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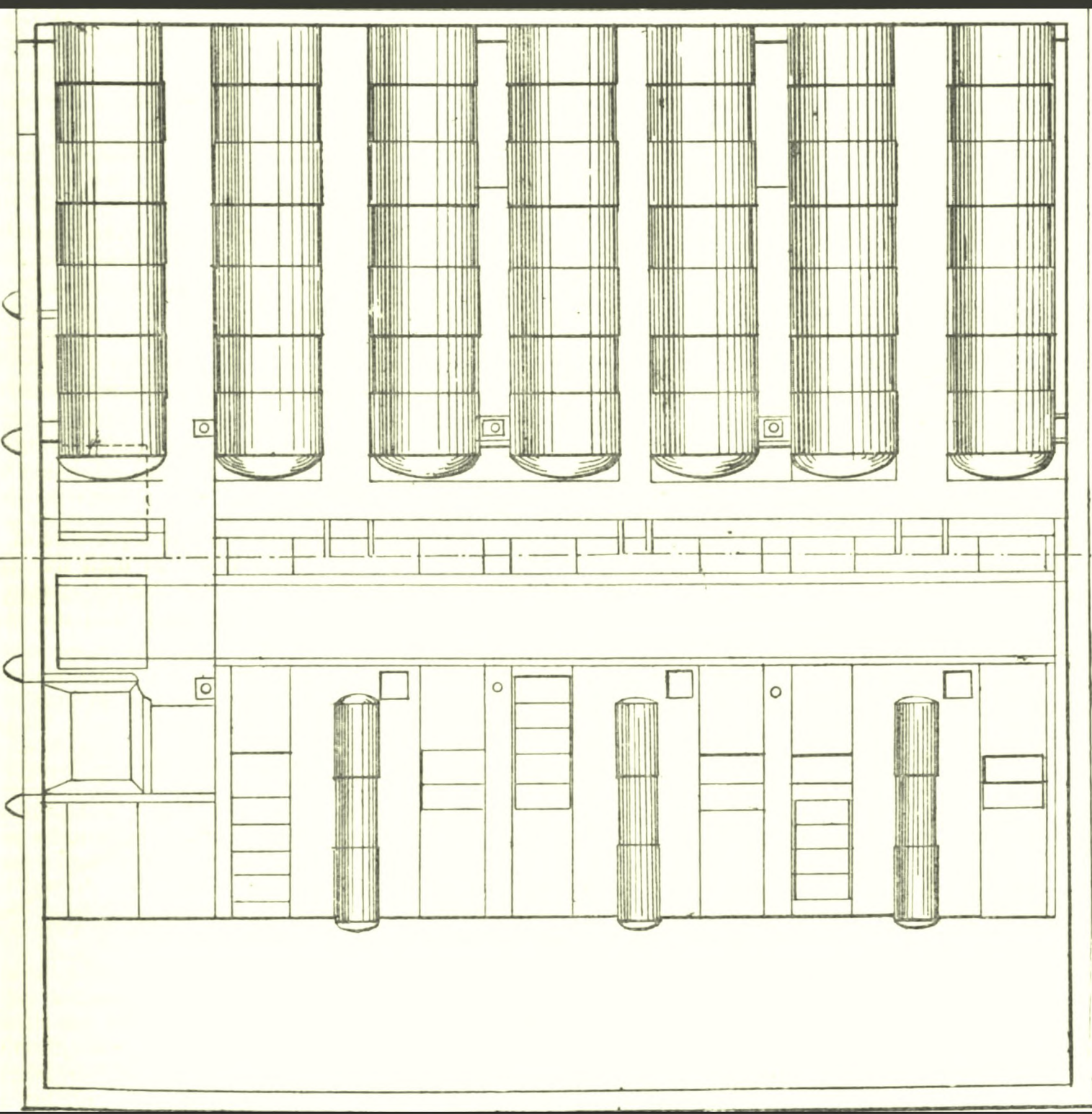

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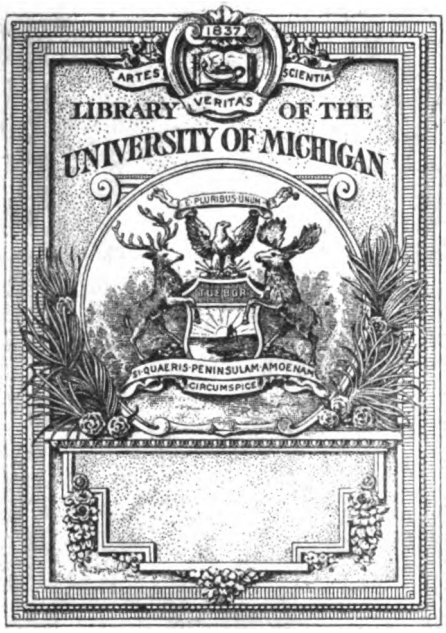
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THE

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NOTES.

The Kiel Fetes.—The electric illuminations of the British men-of-war seem to have been exceptionally tasteful.

The Copenhagen-Hamburg Telephone line will be opened this month, when work will at once be commenced on the extension to Berlin.

Book Received.—"Notes on Submarine Telegraph Cable Work: Grappling," by Walter Goodsall, late commander of the Eastern Telegraph Company's s.s. "Chiltern," illustrated by the author (1s.).

More Electrical Exhibitions.—Negotiations are being made for the organisation of an exposition of electrical appliances at Reims, while the North German Commercial and Industrial Exhibition, which has just been opened at Lübeck, has a considerable electrical section.

The Proposed Pacific Cable.—A Reuter telegram says that the vice-president of the San Francisco Chamber of Commerce is convinced that a Pacific cable will shortly be laid by a group of British capitalists, and that the route chosen is from Auckland to Vancouver, by way of Norfolk Island, Fiji, and Fanning Island.

Institution of Civil Engineers.—The council of the Institution of Civil Engineers have reappointed as treasurer Mr. Hugh Lindsay Antrobus, the senior partner in Messrs. Coutts and Co.; as honorary secretary, Dr. William Pole, F.R.S.; and as the secretary, Mr. James Forrest, which office he has filled for the past 39 years.

Electric Meter Trials in Paris.—Our note on this subject in last week's issue, p. 731, must be subjected to a correction. The French journal from which we borrowed the account of the trials states in its latest number that the number of failures attributed to the Aron meter should, instead of 15 per cent., be 16 per 1,000, or 1·6 per cent.

Niagara.—A telegram from New York states that electric power transmitted for commercial purposes from Niagara Falls was sent on Tuesday through the electrical subway to a manufactory a mile distant. Four thousand horse-power was delivered and used in an aluminium establishment. The telegram adds that a rapid extension of the Niagara Power Company's operations is expected.

Electric Railway for Oberammergau.—Oberammergau, of Passion Play renown, is to have its electric railway. Messrs. O. L. Kummer and Co., of Dresden, have obtained a ministerial concession for the construction of a line between Murnau and Ammergau by way of Kohlgrub. It is also proposed to supply electric power for lighting and industrial purposes to places contiguous to the railway.

Electricity in Mining.—The use of electricity in South African mining operations continues to steadily increase. A report from the Sheba Mine states that extensive alterations are being made in connection with the new electric installation, while at the City and Suburban Mine a dynamo is being placed in the workshops to supersede the present shop engine, which is driven by the boilers of the old plant.

Electric Fatality.—Carelessness has begot another fatal accident. A fitter in the employ of the Internationale Elektrizitäts-Gesellschaft, of Vienna, has been killed by an electric current while handling some wires in the cellar of a palace in the Ringstrasse. The unfortunate man omitted to wear the prescribed pair of indiarubber gloves. He was seen suddenly to stick to the wires, the fingers of the left hand were burnt to the bone, and he dropped dead in a few seconds.

On the Continent.—The electrical industry seems to be flourishing in Central Europe, if we may judge from newspaper reports. Messrs. Schuckert and Co., of Nuremberg, it is reported, are so well supplied with orders for both lighting and traction work, at good prices, that they are engaging a large number of fresh hands. Italy, British firms might note, is stated to be offering the best field for German electrical enterprise at present. Then the formation of still another electrical trust company is announced from Budapest. This new company is to be financed by the Ungarische Kommerzialbank, and will be connected with the Berlin Allgemeine Elektricitäts-Gesellschaft.

Opposition to Electric Tramways.—An episode in connection with the proposed electric tramways in Quebec reminds one of the pother caused through the supersession of stage coaches by steam-hauled carriages; and also, in a less degree, of the artisanal opposition to the introduction of the spinning-jenny. It seems that the blacksmiths, horseshoers, harnessmakers, and hackdrivers of Quebec have made an energetic protest against the granting of a permit to build an electric tramway in that city, for the reason that it will interfere with their means of earning a living. There is sound common sense in the saw that counsels a man not to beat his head against a stone wall.

Electric Traction for Bombay.—On the subject of Madras tramways, a correspondent of *Indian Engineering* points out that if direct steam propulsion on the Batavian model is adopted for Madras the electric plant would be found extremely serviceable at Bombay, where the conditions are very favourable for electrical traction. The Bombay tramways are now horsed, but the expense must be heavy, and waste of animal life (as with all tramways) excessive. There is little fear of the wires being blown down by a cyclone; overhead wires can be supported without, as a rule, causing any obstruction to traffic, while the Bombay tram routes are for the most part straight and lengthy runs with few complicated junctions. In consequence, the electric system would answer and promise to pay well at Bombay.

The Electrostatic Capacity of Coils.—A paper with this title was recently communicated by M. J.

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Cauro to the Académie des Sciences (*Comptes Rendus*, 1895, p. 308). As is known, coils that are double wound may be regarded as possessing a capacity which increases rapidly with the resistance, but as having a self-induction which is small enough to be negligible. In the ordinary method of estimating self-induction, the algebraic sum of the self-induction and the capacity is ascertained, and since capacity is equivalent to a negative self-induction, the result of such a measurement may be either positive or negative. If positive, the algebraic sum may be made equal to zero by the introduction of a sufficient amount of paraffin to increase its capacity; if negative, the self-induction may be increased by the introduction of a suitable soft iron core. The capacity may be considerable, and must be eliminated whenever the elimination of self-induction is considered necessary. M. Cauro states that in his attempts to reduce the combined effect of self-induction and capacity in resistance coils, he has obtained excellent results by starting the winding of alternate layers of wire from the same end of the bobbin.

The Iron and Steel Institute.—The following is a list of the papers which it is expected will be read during the autumn meeting of the Iron and Steel Institute, which takes place in Birmingham on August 21, 22, and 23 next: (1) "The Direct Puddling of Iron," by E. Bonehill; (2) "The Thermo-Chemistry of the Bessemer Process," by Prof. W. N. Hartley, F.R.S.; (3) "The Hardening of Steel," by H. M. Howe; (4) "The Mineral Resources of South Staffordshire," by H. W. Hughes, A.R.S.M., F.G.S.; (5) "The Iron Industry of South Staffordshire," by D Jones, secretary of the South Staffordshire Ironmasters' Association; (6) "Tests of Cast Iron," by W. J. Keep; (7) "Small Cast Ingots," by R. Smith-Casson; (8) "The Estimation of Oxide of Iron in Steel," by A. E. Tucker, F.I.C.; (9) "Tests of Cast Iron," by T. D. West; (10) "The Use of Nickel in the Metallurgy of Iron," by H. A. Wiggin. The chairman of the local reception committee in Birmingham is Sir Benjamin Hingley, Bart., member of council of the Iron and Steel Institute; the treasurer is Mr. Arthur Keen, member of council of the Iron and Steel Institute; and the hon. secretary is Mr. Leigh H. Elkington, 10, Newhall-street, Birmingham.

The Institution Conversazione.—The conversazione of the Institution of Electrical Engineers, which took place in the galleries of the Royal Institute of Painters in Water Colours, in Piccadilly, W., on Wednesday evening, was numerously attended by members and their friends, who were received by the president of the Institution, Mr. R. E. B. Crompton. An addition to the ordinary attractions of the galleries was provided by the band of the Royal Horse Guards (Blue), under the conductorship of Mr. Charles Godfrey. The gathering was a very successful one. Among the guests were: Prof. W. Grylls Adam, F.R.S; Prof. W. E. Ayrton, F.R.S.; Mr. G. L. Bristow; Sir James Crichton-Browne, F.R.S.; Mr. H. W. Christmas, Consul-General for Servia; Prof. W. Crookes, F.R.S.; Sir David Dale, Bart.; Mr. Henry Edmunds, president Northern Society of Electrical Engineers; Mr. W. B. Esson; Sir John Evans, K.C.B., F.R.S.; Prof. G. Carey Foster, F.R.S.; Mr. S. Z. de Ferranti; Prof. George Forbes, F.R.S.; Mr. Robert Kaye Gray; Sir Thomas Gordon; Dr. J. H. Gladstone, F.R.S.; Lord Greenock; Prof. D. E. Hughes, F R.S.; Dr. John Hopkinson, F.R.S.; Charles Hawksley; Dr. Vernon Harcourt, F.R.S.; Lord Kelvin, P.R.S.; Mr. P. V. Luke, C.I.E.; Mr. W. M. Mordey; Sir Henry Mance, C.I.E.; Mr. Kenric B. Murray; Sir Colin Scott Moncrieff; Prof. Perry, F.R.S.; Mr. C. E. Spagnoletti; Sir David Salomons, Bart., M.A.; Mr. Alexander Siemens; Mr. Carl von Siemens; Prof. S. P. Thompson, F.R.S.; General Webber, C.B., M.I.C.E.; Mr. E. Woods, past-president Inst.C.E.

A Queer Case.—It is not often that diabolically ingenious attempts to damage the machinery of a manufacturer such as those which have been alleged at the Greenock Court against one John Whitelaw are brought to light. This person was charged with "having formed a wilful and malicious scheme for injuring the trade carried on by John Henry Cox, electroplater and engineer, 13, Nicholson-street, Greenock, the property and machinery there, and interfering with the working of his machinery and the peaceful carrying on of the business at the said premises." It is stated that the defendant, between January 1, 1893, and August 31, 1893, bored holes in the floor of his (accused's) workshop at 13, Nicholson-street, and through these holes repeatedly poured, or caused to flow, water into the workshop below occupied by Mr. Cox in order to damage certain polished articles therein and interfere with the working of a polishing lathe, and that at the same time and place the accused of intent dropped a heavy iron weight on the floor of his workroom with the effect of slackening the fastenings of the machinery in Mr. Cox's workshop. Other counts include a charge of having between March 1, 1894, and April 10, 1895, loosened a bolt in the floor of his workshop fastening a travelling crane in Mr. Cox's workshop for the purpose and with the effect of causing the crane to fall and be damaged, whereby the life of Archibald Dallis, apprentice engineer, was endangered. The case has aroused great interest in electroplating circles, and the hope is generally expressed that, if the charges be substantiated, the offender will receive just punishment for his contemptible acts.

Electric Lighting in Calcutta.—Electric lighting in the city of palaces cannot, *Indian Engineering* complains, be brought to bear on the darkness without a special legislative Act enacting provisional orders for the supply of electricity. The Indian Telegraph Act of 1885, under which licenses have been granted to telephone companies, has no application. Neither has Act XIII. of 1887, which was passed to provide for the protection of person and property from the risks incidental to the supply and use of electricity, but which does not provide for the grant of licenses. As a matter of hard fact, our contemporary asserts, it provides effectually for nothing at all. The new Bill now on the legislative anvil closely follows the English Act of 1882, though, since it is intended to empower the local government to grant licenses only, all references to "provisional orders" and "special Acts" have been omitted from the document; throughout which the Bengal Government has been substituted for the Board of Trade, as one of the high contracting parties. The definition of Calcutta limits is derived from the Calcutta Municipal Act of 1884, but in that Bill power is given to extend its provisions to the Howrah Municipality. Necessary powers for blocking streets, etc., for the purpose of supplying electricity within the area specified by the license have been, for the most part, adopted from the Gasworks Clauses Act of 1871. "Let us hope," the journal concludes, "that the new electric lighting scheme will pass legislative muster without any more obstructiveness from a jealous gas company, without exciting any more municipal feuds, and redundantly to the credit of everyone concerned with a creditable apportionment of municipal moneys."

Scope for Electricity in Japan.—A correspondent who has recently returned from a visit to the East emphasises the need of electric railways in Japan. Tokio, he says, has now considerably more than a million inhabitants. It is only 14 miles distant from Yokohama, the

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intermediate country is thickly populated, and he is quite certain that an electric railway between the two points would pay. At present there are no electric railways in Tokio, and there are no tramway lines in Yokohama. Take the town of Osaka, in the central part of the empire, he continues; it has, with its suburbs, an enormous population, and there is not an electric railway in it. It is 16 miles from the coast, and is connected by railway with the town of Kobe. Kobe was very small at the time that Japan was first opened to foreign trade, but according to the census of 1890 it contained 136,000 people. An electric railway between Kobe and Osaka ought to prove a remunerative undertaking. This part of Japan is one succession of villages, and only a few miles west of Osaka is the great city of Kioto, which was for years the capital of Japan. If an electric line were laid from Kobe to Osaka, and thence to Kioto, it would touch villages at almost every mile of its course, and it would accommodate a population of fully 2,000,000 people. The Japanese are great travellers. They make long excursions over the country in order to visit the most sacred Buddhist temples and Shinto shrines, and hundreds of families are met walking along the roads from one sacred place to another. The railway carriages are well filled, and electric lines would pick up many parties out on these trips of combined religion and pleasure. As to the electric light field, the correspondent concludes, that is also great.

British Telephone Trunk Lines.—The telephone trunk-wire system of the Post Office was definitively inaugurated on Monday, when Mr. Spencer Walpole (secretary to the Post Office) and Mr. W. H. Preece (engineer-in-chief and electrician) spoke over the wires from London to gentlemen in Manchester, Liverpool, Birmingham, Leeds, Hull, Bristol, Cardiff, Derby, Newcastle-on-Tyne, Leicester, Nottingham, Plymouth, and Sheffield. We gave some particulars of the provisional opening of the new service in our issue of June 14, p. 677, and upon that occasion civic amenities were exchanged, mayoral jokes were cracked over the wires, and the soothing strains of a bagpipe were borne along the line from Glasgow; while one or two municipal officials adroitly utilised the opportunity to sound the London staff, much to its consternation, as to when replies might be expected to certain written communications. It was a subject of comment that the telephones did not seem to work quite so well when it was endeavoured to obtain an answer to these interrogations. It is, perhaps, natural that Austrian electrical engineers should manifest considerable satisfaction that our postal authorities have adopted the Deckert transmitter for the trunk lines. The *Zeitschrift für Elektrotechnik*, the organ of the Vienna Elektrotechnischer Verein, for example, talks of a "victory for Austrian industry"; while congratulations have poured in upon Herren Deckert and Homolka, of Vienna, the inventors and makers of the graphite loud-speaking microphone which is named after the head of the firm. It may be mentioned that the scale of charges laid down in the Treasury minute for a telephonic conversation of three minutes is as follows: for any distance not exceeding 20 miles, 3d.; for any distance exceeding 20 miles and not exceeding 40 miles, 6d.; for every additional 40 miles, or fraction thereof, 6d. Where a submarine cable is used, or where exceptional expense is incurred, an additional charge may be made.

The Drawback Telephone.—The *Electrical Age* of New York is the journal whose enterprise—we have it on its own authority—"stands out in strong relief against the lethargy of the oldest electrical papers;" it is the journal which conceived the ingenious idea of publishing a "Married" column, and it is the journal whence we extract, without apologies, the following interesting and instructive paragraph: "The Drawbaugh Telephone and Electric Company, of Reading, Pa., has been organised to manufacture, buy, rent, lease, and sell electric and magnetic telephones, electric machinery, and novelties, and also to buy, lease, rent, and erect telephone lines and exchanges, and to manufacture, buy, and sell telephone supplies and engage in and prosecute a general telephone business, using and operating telephones. Messrs. C. W. Ream and G. Milton Bair, 17, North Sixth-street, Reading, Pa., are the sole owners of the latest devices in telephones invented by Daniel Drawbaugh, the original inventor of telephones, and are actively engaged in presenting the merits and advantages of the new Drawbaugh telephone to the public. They have received permission from the Postal Telegraph Cable Company to use their poles within the city limits, and tests of great variety are made. The instrument used is a district, or short-distance phone. The Drawbaugh phone is claimed to be superior to any other because of its transmitter, which is a simple arrangement, consisting of a sponge always adjusted and between the plates a carbon. There is no induction, and sound is conveyed under seemingly the most adverse circumstances. A test was made by Mr. Bair, who stood 5ft. away from the phone and yet could be distinctly understood. He turned his back on the phone and his voice was heard, and he then closed the transmitter with his handkerchief, and still his voice could be plainly heard. A watch was held 3in. away from the phone and the ticking was plainly distinguished at the other end of the line. These tests cannot, it is said, be made with any other phone, because they have tried 30 kinds and all failed."

Electric Headlights.—Considerable progress has, it appears, been made in the Western States with electric headlights for locomotives, and Mr. G. C. Pyle, of Indianapolis, who has been identified with this work, has just brought out (our contemporary, the New York *Electrical Review*, says) an improved combination for this service, in which the mechanism is simplified and the wear consequently reduced. These generators are customarily mounted on the top of the smoke-box, behind the headlight projector, and either before or behind the stack. The dynamo is driven by a compound steam turbine of high speed, and the apparatus is described as follows: The steam is expanded four times before it is exhausted into the atmosphere. The governor is on the turbine wheel. The dynamo and turbine are on one base-plate, which is attached to the engine in such a manner as to preserve the alignment. The armature and commutator, which weigh but 23lb., are on the engine shaft, which runs at 2,000 revolutions a minute. The electrical balance of the dynamo is said to be so perfect that no spark can be seen at the brushes. The electric lamp can be placed in any ordinary headlight reflector by removing the oil lamp. Only one carbon is employed, a short piece of copper being used for the negative electrode. The entire plant is 19in. long, and weighs 211lb., the weight of the lamp being 15lb. The only wearing surface is the shaft, and this runs in oil. The two bearings are 3½in. and 6½in. long, and the weight of shaft, armature, and turbine wheel is but 40lb. As there are no internal wearing parts requiring oil, it is not considered necessary to supply a sight-feed lubricator in the cab for the dynamo. One ⅝in. carbon, costing 1¼ cent, will run about eight hours, which, it is asserted, practically constitutes the expense of running the light for that length of time. Among the claims made for the device are that in operating the plant dry or wet steam may be used, and it is said to make no difference if a full head of high-pressure steam is suddenly turned on, as there can be no reaction

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or backlash. The whole mechanism may be started with one turn of a ½in. valve.

Electrical Thief-Traps.—A smart capture of what Americans call a sneak-thief by the medium of an electrical detector designed by Mr. G. H. O'Connor, of Chicago, is reported from that city. On the fifth floor of a large manufactory is a department employing a number of girls, who had been complaining for several months of thefts committed in their dressing-room on the sixth floor while they were at work. Silk handkerchiefs, veils, and money disappeared with increasing frequency, until at length the management began to realise that it was time steps were taken to secure the delinquent. As the dressing-room was kept locked, the key being accessible only to those engaged in the department where the losses were reported, it was decided that one of the girls using the room was rifling the pockets of the others. A trustworthy girl was accordingly taken into the confidence of the management; a double wire was sewn in the lining of her cloak, connecting a spring jaw in the pocket with the two hooks on which the cloak hung. The jaws were placed in contact with one of the wires and insulated from each other by a small tongue of leather placed between them while forced apart, and this tongue, again, was sewn to the bottom of a purse. Each of the two brass hooks supporting the garment was held in place by a long brass screw which went through the partition and connected with a wire on the outside of the dressing-room. Here the wires were carried under a moulding, through the floor, to a single-cell battery, and a bell, placed in series, was hidden in the room where the girls were at work 50ft. away. A switch was placed in a convenient position, which broke the circuit, until the other arrangements were completed. After closing the switch the only opening in the circuit was at the spring jaws, which would be brought together by removing the purse and insulating tongue. The trap had been set but three hours when the bell rang vigorously and the owner of the cloak hurried to the dressing-room and there found the guilty girl, who was immediately accused of theft and discharged after she had admitted the offence. Why a real detective was not called in to complete the admirable work of the electrical thief-catcher, and thus prevent the maiden with pilfering propensities from pursuing her malpractices in some other factory, remains a mystery.

Three-Phase Installations.—An interesting power-transmission plant is in course of installation at Bayonne, N.J., where the three-phase system of the General Electric Company will be employed to operate the machinery of the Tide Water Oil Company. This company is allied with the Standard Oil Company, and is engaged in exporting the refined products of petroleum. The nature of the process is such that spark-proof apparatus is imperative, and multiphase apparatus was selected as best fulfilling the peculiar conditions. The generator will be a 550-volt three-phase General Electric machine, having eight poles and a capacity of 75 kilowatts. The several induction motors will be of 5 h.p., 10 h.p., and 15 h.p. Some of these are spark-proof, and have a permanent resistance in the armature circuit. A peculiar interest attaches to these motors, as they will be employed in places where there exists an ever-present danger of explosion from gases, which a spark could readily ignite. They will be used to operate pumps, elevators, and other machinery. The switches will be of special construction, with blades immersed in oil. The generator also supplies current for about 525 lights scattered throughout the different parts of the works. Regulation of the lighting circuits will be effected by revolving regulators of novel design. Its first application of the three-phase long-distance system to tramway work will be made by the General Electric Company at Lowell, Mass., where a plant is in course of construction for the Lowell and Suburban Street Railway Company. In the first place, the generators will deliver both alternating and continuous current, and when not in use for transmission work will be run in parallel with the railway generators now in the station. They will be wound for low-voltage current at the alternating side, and this current, raised to 5,000 volts, will be carried to two sub stations—one nine miles and the other 14 miles distant from the generating station. Each sub-station will be provided with step-down transformers of the air-blast type and two rotary converters. These machines are constructed to maintain at the commutator brushes 5,000 volts at no load and 550 volts at full load. Another transformer sub-station for 400 incandescent lamps will be installed six miles from the generators. The success of this plant, the *Western Electrician* remarks, will go far towards solving the problem of the operation of railways over long distances, taking the current from one power station.

Direct Production of Electricity from Hydrogen. Mr. H. H. Dow, an American electrician, publishes the following figures on the efficiency with which hydrogen is oxidised in air in the Dow air battery. This cell contains no depolarising agent, but depends entirely upon the oxidation of the nascent hydrogen by air to keep it from polarising. It is composed of zinc and carbon electrodes in a saturated solution of calcium bromide. The carbon used is very porous, and by capillary action holds some of the electrolyte within its pores, although its outer surface is largely exposed to air. The reaction that takes place on the zinc electrode is expressed by the equation $Zn + CaBr_2 + 2H_2O = ZnBr_2 + CaO_2H_2 + H_2$. The zinc bromide and calcium hydrate thus formed react on each other with the formation of zinc hydrate and the same amount of calcium bromide with which a start was made, $ZnBr_2 + CaO_2H_2 = ZnO_2H_2 + CaBr_2$. The result so far as total energy generated at the zinc electrode is concerned can, therefore, be expressed by the equation $Zn + 2H_2O = ZnO_2H_2 + H_2$. The H_2 would, however, when the circuit was closed, appear on the carbon electrode, where it would accumulate and polarise the cell unless oxidised. The reaction that takes place on the carbon electrode is simply the combustion of the hydrogen by the oxygen of the air, producing water. The original and final products may therefore be represented by the following simple equation: $Zn + O + H_2O = ZnO_2H_2$. By substituting the heat of combustion for the water and zinc hydrate we find that 82·68 heat units would be developed, which corresponds in this case to almost exactly 1·8 volt if all the energy appeared as electricity. Similarly, if all the energy was transformed into electricity in the same battery without access of air, according to the equation $Zn + 2H_2O = ZnO_2H_2 + H$, only ·3 volt would be produced. The 1·5 volt difference between the two cases is produced solely by the oxidation of the hydrogen. The actual voltage found in these air cells is 1·32, or 1·02 volt more than if no air had been present. Therefore, in this case $\frac{102}{180}$, or about 57 per cent., of the total energy contained in the hydrogen was converted into electricity. This result, showing five times the efficiency of our best steam-engines, at first appears very remarkable, but in this case nascent hydrogen was oxidised, while in the case of heat-engines the free hydrogen is burned. An experiment with a similar cell having two carbon electrodes and depending entirely on hydrogen gas and air for the production of its current gave less than one tenth of a volt E.M.F.

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Measuring Hysteresis.—On April 26 we reported the paper read by Prof. Ewing before the Institution the previous evening on "A Magnetic Tester for Measuring Hysteresis in Iron." In the discussion which followed one of the other professors mentioned that the American Prof. Elihu Thomson had done something in the same line. The *Electrical World* of New York has just made the same discovery, and says: "It will doubtless interest Americans to learn that a very similar instrument was suggested and used by Prof. Elihu Thomson quite a number of years ago, and which in some respects appears to have been even an improvement on the Ewing form. As early as 1889 Prof. Thomson made some experiments with an instrument for measuring hysteresis which depended on driving sample discs of iron in a magnetic field by a small meter motor, and measuring the amount of a current required to be put through the meter, which thus became a measure of the torque exerted in the magnetic field. A speed counter was included in the instrument. The discs were stamped out by a standard punch, and a set of them were strung on a vertical shaft; the field in which the armature revolved was furnished by a definite current. He used the instrument for determining the hysteresis in different samples of iron as also in a modified way by taking the bundle of discs and winding on them a simple drum winding provided with a commutator, by which means he was able to drive the discs, which then became the armature core, between the poles of an electromagnet, the strength of which could be made less or greater; as in the other form the armature current was measured, giving a measure of the hysteresis or the total work done in revolving the bundle in the magnetic field. The friction error was fairly constant, and a correction had to be made accordingly. In the other form of apparatus in which the meter armature was driven by a current, the correction could easily be made by revolving the discs and shaft by a current passed through the meter armature while the field which magnetised the disc was removed, making readings at various speeds and noting the current required to drive the apparatus at these speeds; this current deducted from the total with the field on, at any given speed, would show at once the current required to do the work of rotating the discs—that is, of supplying the energy lost in hysteresis at various speeds, allowing for eddy-current effects. A modified form of the instrument has been used by the General Electric Company for some time and we believe is still in use by them for testing the samples of iron."

The New Central London Electric Railway.—Arrangements are being made for practically commencing the Central London Railway, for which three Acts of Parliament have been obtained. These Acts, passed in the course of the last three years, authorise the construction of an underground railway, running in a line almost straight from Shepherd's Bush to the open space in front of the Mansion House and the Royal Exchange, and thence to Liverpool-street, where, subject to arrangements being made with the Great Eastern Railway Company, it is proposed to construct a terminal station underneath their terminus. By the system of constructing underground lines so successfully illustrated in the electric railway running from the Monument to Stockwell, and by the line now in course of construction between the City and Waterloo, the new line will be carried out without the least disturbance of the streets or any peril to property. Its length will be 6½ miles, and there will be 14 stations. Starting with electrical generating works and a station at Shepherd's Bush, there will be another station at Queen's-road, and one at Holland-park. The next will be at Notting Hill-gate, another at Westbourne-terrace, and another at the Marble Arch. Running straight down Oxford-street, there will be stations at Bond-street, Oxford-circus, Tottenham Court-road, the British Museum, and Chancery-lane. The line is to run under the Holborn Viaduct, to Newgate-street, where there will be another station, and thence with a slight deviation—unless the alterations contemplated by the City authorities should first be carried out, in which case this curve will nearly disappear—into Cheapside. The next station will be at the Bank, and thence the line will run alongside the Royal Exchange into Broad-street and on to Liverpool-street, passing on its way under the Circle Railway. Throughout its length the line will be carried through the London clay. There will be two tunnels, similar to those in the City and Southwark electric railway, but of larger diameter. They will be pierced by the Greathead shield system on precisely the same method that is adopted on a gigantic scale for the Blackwall tunnel. There will be no opening of the streets. Property will be purchased in accordance with the parliamentary powers conferred for the stations at the various points indicated, and from these various properties the tunnels will be driven, while the traffic overhead will go on quite undisturbed. From the West-end to the City the two tunnels, one for the up line and one for the down, will run side by side. The engineers, however, are forbidden to go under any building, and in the narrow City streets there is not sufficient room to carry the two lines side by side. They are, therefore, to run along one above the other, the lower one going past Bow Church, Cheapside, at a depth of 80ft. below the surface of the roadway. Emerging in the open space in front of the Mansion House and the Royal Exchange, the new line is to bring about a remarkable London improvement. All Londoners know the crowded and dangerous condition of the streets just here, and nervous people well know the difficulty of crossing the roadway at any hour of the day. Arrangements have been made with the Corporation by which the company will be allowed to build their station underground in the middle of this space, on condition that they construct a spacious subway for pedestrians all round it. This subway will be 15ft. wide, and will be accessible by easy flights of steps from all the surrounding thoroughfares. Foot passengers will thus be able to avoid crossing the roads at this point. A person may start at the Mansion House, descend a few steps, cross the end of Cheapside, of Princes-street, Threadneedle-street, Cornhill, Lombard-street, and King William-street, back to the Mansion House in perfect safety, while from this subway he will also be able to pass down to the station of the City and Waterloo line, or to that of the Central London Railway, which is to have, in addition to the several entrances at the end of the converging thoroughfares, two broad flights of steps leading down from each side of the pavement immediately in front of the steps of the Royal Exchange. The ground at this point in the City, it need hardly be said, presents a wonderful tangle of pipes and drains and cables and wires, and for these also the new railway has undertaken to make ample provision. Beneath the subway for foot passengers will be another subway about three times as large as will be required for taking in all the underground pipes and so forth, and which may therefore be expected to obviate any further disturbance of the roadway for generations to come. The main features of the new line will be those of the City and Southwark railway, with such modifications and improvements as the experience gained by that undertaking has suggested. That line, it may be remembered, was originally intended for working by cable. Electricity was an afterthought.

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THE THEORY OF ALTERNATING CURRENTS.—VI.

BY A.INST.E.E.

§ 18. **Capacity and Condensers.**—In § 16, impedance was defined as the sum of every form of obstruction met with in alternating-current circuits, and as the component, reactance, often includes a factor due to capacity, we shall now briefly explain capacity and condensers, and then consider the effects produced when condensers are present.

Capacity, as is well known, is the power of a body to hold a charge of electricity, and is measured by the quantity of electricity required to raise the potential of the body by unity. It follows from this definition that the potential, E, of a body charged with Q units of electricity is proportional to Q, or, algebraically,

$$E \propto Q,$$

and $\therefore Q = K \times E$, where K denotes the capacity.

Now, the capacity of a conductor is increased by bringing near to it another conductor which is separated from it by an insulating medium or dielectric, and any device which exhibits a rise of potential when an accumulation of a quantity of electricity has taken place is termed a condenser.

Standard condensers consist of a number of parallel plates of tinfoil or other conducting sheets, separated by very thin sheets of mica, the first, third, and fifth, etc., and the second, fourth, and sixth plates, etc.—that is, the alternate conducting plates—being connected together so as to form two series of plates, which are connected to two brass pieces or poles on the outside. These form the terminals of the condenser. One set of plates receives a quantity of positive electricity when charged, whilst the other set is charged with an equal quantity of negative electricity. The two terminals may be connected by a plug so as to short-circuit the condenser. Insulated cables have a certain amount of capacity, and practically form condensers. Concentric cables have considerable capacity, especially when of great length, consequently capacity may be a very important factor in alternating-current distribution, and should not be neglected.

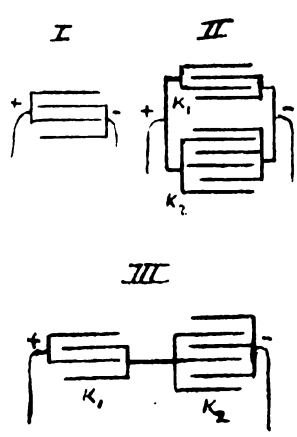

FIG. 12.

It will be well to notice here that a capacity of a condenser consisting of parallel plates, or in the case of a concentric cable of two conductors, is measured by the quantity of electricity on one plate or conductor when there is unit difference of potential between the plates or conductors. So far, the units referred to are C.G.S. units in the electrostatic system, whilst for practical purpose we require a unit of capacity corresponding to the volt, ampere, etc. This is termed the *farad*, and a condenser with a capacity of one *farad* requires one coulomb of electricity to produce a difference of potential between its poles equivalent to an E.M.F. of one volt. Since $Q = K E$,

$$K(\text{farads}) = \frac{Q\ (\text{coulombs})}{E\ (\text{volts})} = \frac{\text{charge on one pole}}{\text{D.P. between the poles}} = \text{a ratio},$$

and

$$1 \text{ farad} = \frac{1 \text{ coulomb}}{1 \text{ volt}} = \frac{10^{-1} \text{ G.G.S. unit}}{10^{8} \text{ G.G.S. units}} = \frac{1}{10^{9}},$$

or 10^{-9} C.G.S.

For practical purposes, however, the farad is too large, and the one-millionth part of a farad—*i.e.*, one *microfarad*—is the practical unit of capacity adopted by electrical engineers. A condenser with a capacity of one microfarad will thus require only one-millionth of a coulomb to charge it to one volt. Standard condensers of one-third microfarad capacity are used for testing purposes, since this value is approximately equal to the capacity of one nautical mile of Atlantic cable. Fig. 12 (1) shows the usual symbol for condensers, whilst (2) and (3) represent condensers connected "in parallel" and "in series" respectively.

In (2) and (3) it will be noticed that the two condensers connected have capacities K_1 and K_2, and it will be useful to remember that the capacity, K, of the whole arrangement is found as follows:

(1) *Parallel Arrangement*—

$$K = K_1 + K_2.$$

(2) *Series Arrangement*—

$$\frac{1}{K} = \frac{1}{K_1} + \frac{1}{K_2}; \text{ or } K = \frac{1}{\frac{1}{K_1} + \frac{1}{K_2}}.$$

It will be evident from the nature of a condenser that the capacity of such a device depends upon the size and geometrical form of the conductors, and upon the nature and thickness of the dielectric. We give here formulæ for determining the capacity of condensers in microfarads.

(1) Sphere:

$$K \text{ (microfarads)} = r/900{,}000 \text{ (radius} = r).$$

(2) Two concentric spheres:

$$K = k \frac{r\,r'}{r' - r} \Big/ 900{,}000 \left\{ \begin{matrix} \text{radii} = r \text{ and } r' \\ \text{specific inductive capacity} = k \end{matrix} \right\}.$$

(3) Cylinder:

$$K = \frac{l}{2 \log_e \frac{l}{r}} \times \frac{1}{900{,}000}; \text{ radius} = r, \text{ length} = l.$$

(4) Two concentric cylinders or concentric cable:

$$K = k \frac{l}{2 \log_e \frac{r^1}{r}} \times \frac{1}{900{,}000} \left\{ \begin{matrix} \text{internal radius} = r. \\ \text{external radius} = r^1. \end{matrix} \right.$$

(5) Parallel discs:

$$K = k \frac{A}{4 \pi t} \times \frac{1}{900{,}000} \left\{ \begin{matrix} A = \text{area}. \\ t = \text{thickness of dielectric}. \end{matrix} \right.$$

In all cases lengths are in centimetres, and k is the specific inductive capacity of the dielectric. It must also be noticed that

$$\log_e \frac{r^1}{r} = \left(\log_{10} \frac{r^1}{r} \right) \times 2{\cdot}3026.$$

An example taken from practice will simplify the method of determining the capacity of a condenser. The case we will consider is the concentric cable forming the trunk main connecting Deptford to the transformer sub-stations in the Metropolis. An idea of the cable may be gathered from Fig. 13, in which is given section of the cable, and,

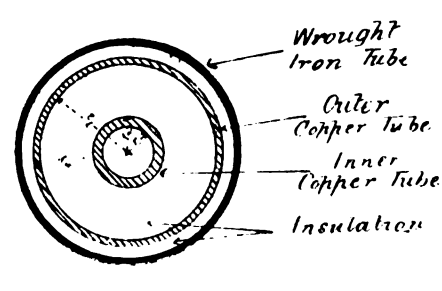

FIG. 13.

as we have already said, such a cable possesses capacity to a considerable degree.

The inner tube, A, and the outer tube, B, are copper

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tubes, whilst C is a tube of sheet iron enclosing the cable, the three tubes being insulated from one another by an insulating material made of compressed brown paper and black wax, the specific inductive capacity of which is 3·37.

The values of r_1, r_2, r_3, and r_4 in Fig. 13 are as follows:

$r_1 = \cdot281$in. $\quad r_3 = \cdot922$in.
$r_2 = \cdot406$in. $\quad r_4 = \cdot969$in.

By applying the formula in (4) above, and using the data just given, we will calculate the value of the capacity of one mile length of this cable.

$$K\ (\text{microfarad}) = \frac{K \cdot l}{2 \log_e \frac{r^1}{r} \times 900{,}000}.$$

Since l = 1 mile = 160,931·5cm., K = 3·37;

$$\frac{r^1}{r} = \frac{\cdot922}{\cdot406} = 2{\cdot}27 \therefore \log_e \frac{r^1}{r} = (\log_{10} 2{\cdot}27) \times 2{\cdot}3026;$$

and $$K = \frac{3{\cdot}37 \times 160{,}931{\cdot}5}{2 \times 2{\cdot}3026\ (\log_{10} 2{\cdot}27) \times 900{,}000}$$ microfarad

= ·3675 microfarad.

§ 19. **Capacity and Reactance.**—With continuous currents a condenser practically opposes the flow of electricity when once charged, whilst it allows an alternating current to flow in and out, or, in other words, to pulsate backwards and forwards through its dielectric. It is obvious from the nature of condensers that so long as the current flowing to a condenser is positive, the charge on the condenser increases, so that the charge is greatest, and therefore the pressure between the plates is a maximum in the positive direction, just at the moment when the current is changing from + to −, that is, when the current is zero.

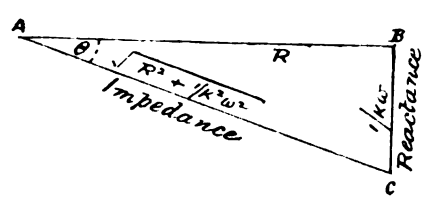

Fig. 14.

When the current changes its direction, the condenser begins to discharge itself, giving out a positive current, tending to drive the negative current back. In this way it reacts on the E.M.F. of the circuit tending to produce a *lead* in phase of a quarter of a period. Capacity-reactance, like inductance-reactance, is in quadrature with the current, but in effect it is equivalent to inductance-reactance of magnitude $1/K\omega$. Since capacity tends to produce a *lead*, whilst inductance tends to produce *lag*, capacity-reactance is written $-1/K\omega$. The impedance of a circuit containing a resistance R and a condenser of capacity K farads is $\sqrt{R^2 + 1/K^2\omega^2}$, as is readily seen from the construction of Fig. 14, in which A B represents R, and B C drawn below A B (since inductance-reactance was drawn above A B in Fig. 10, § 16), represents the capacity-reactance, and A C is the impedance as before.

As with inductance, $C = \frac{E}{\sqrt{R^2 + 1/K^2\omega^2}}$, and $\tan\theta = -\frac{BC}{AB} = -\frac{1}{K\omega R}$. As the treatment of the components—the power E.M.F. and reactive E.M.F.—of the impressed E.M.F. when capacity is combined with resistance, is similar to that given in the latter half of § 14, it is unnecessary to go over the ground again. There are, however, several interesting points in connection with capacity that it will be well to notice.

(1) The E.M.F. required *to overcome that* of the condenser is 90deg. *behind* the current, and its maximum value is $\frac{C}{K\omega}$.

(2) Since capacity-reactance $= -\frac{1}{K\omega}$, it may be looked upon as possessing an inductance $= -\frac{1}{K\omega^2}$, that is, a negative inductance, $-L = 1/K\omega^2$. This means that a condenser of capacity K has the power to annul the self-induction of a conductor in series with the condenser to the extent of $1/K\omega^2$ henrys. When $L\omega = 1/K\omega$, the reactance is zero, and as a result the current is in phase with the impressed E.M.F.

§ 20. **Circuits Containing Resistance, Inductance, and Capacity.**—It follows from (2) that $L\omega - \frac{1}{K\omega}$ = the resultant reactance for cases in which R, L, and K are in series. To solve the problem and find C, the equation $C = \frac{\text{impressed E.M.F.}}{\text{impedance}}$ becomes

$$C = \frac{E}{\sqrt{R^2 + (L\omega - 1/K\omega)^2}}.$$

The method of applying this formula will be readily understood by giving the graphical solution of the following problem, shown in Fig. 15, in which A is the alternator

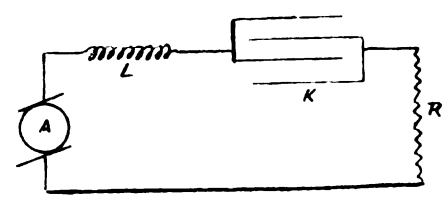

Fig. 15.

giving 2,000 volts effective at a frequency of 100, L is an inductance of ·4 henry, K = 10 microfarads, R = 100 ohms, and it is required to determine the current, C. In Fig. 16, let O B = 100 ohms to scale, O A = L ω, and O C = 1/K ω. Since the capacity-reactance, O C, is negative compared with the inductance-reactance, O A, the resultant reactance is found by making A D = O C—that is, O D is the resultant reactance, and D B = impedance to the same scale as O A, O C, and O B.

In this case $\omega = 2\pi \times 100 = 628{\cdot}3$, and $L\omega = 628{\cdot}3 \times \cdot4$ = 251·32 ohms, $1/K\omega = \frac{1}{\frac{10}{10^6} \times 628{\cdot}3} = \frac{10^5}{628{\cdot}3} = 159{\cdot}1$ ohms.

∴ D O = 251·3 − 159·1 = 92·2 ohms. From which we get D B = $\sqrt{(100)^2 + (92{\cdot}2)^2} = 133{\cdot}8$ nearly.

Or, algebraically,

$$C = \frac{E}{\sqrt{R^2 + (L\omega - 1/K\omega)^2}} = \frac{2{,}000}{\sqrt{(100)^2 + (251{\cdot}3 - 159{\cdot}1)^2}}$$

$$= \frac{2{,}000}{133{\cdot}8} = 15 \text{ amperes.}$$

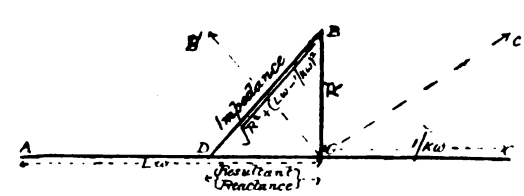

Fig. 16.

Another graphical solution is shown in Fig. 16, which is very useful in some cases. O C¹—shown dotted—is the resultant of O B and O C, and O B¹ is the resultant of O C¹ and O A. It will be noticed that O B¹ = D B.

THE QUALITIES OF MANGIN AND PARABOLIC MIRRORS.

We have received from M. Jean Rey, chief engineer to Messrs. Sautter, Harlé, et Cie., the following reply to the communication of Herr F. Nerz, published in our issue of June 14:

In your issue of June 14 was published a communication from M. Nerz, engineer to the Société Schuckert, relative to the qualities of Mangin and parabolic mirrors. M. Nerz

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sets himself the task of refuting arguments put forward in a prior article of May 17, written in favour of Mangin mirrors.

I have no wish to prolong a discussion at the risk of fatiguing your readers, as I think that the simple geometrical considerations set forth in the article of May 17 were sufficiently clear and precise to enable anyone to easily form his own opinions. May I be allowed, however, to touch upon certain points in M. Nerz's letter.

Firstly, M. Nerz considers the experiments at Toulon as having demonstrated the superiority of parabolic mirrors. I assisted personally at the trials, and I fear that M. Nerz, who was not present, has been wrongly informed by his agents. The committee, which was composed entirely of naval officers, occupied itself solely with results obtained, without considering at all from whence came the apparatus employed. The question set by the Ministry of Marine was one of a purely technical nature, and was as follows: "Do parabolic mirrors possess superiority over Mangin mirrors?" The reply of the committee was unanimously, "No." This is a fact. M. Nerz has been also led into error on the subject of the provision of the particular Mangin mirrors experimented with. They were not constructed specially for the experiments: one of them, a mirror of 30cm. diameter, came from a lot of 20 projectors recently delivered, and the other, a mirror of 90cm. diameter, had been in use since 1889.

Secondly, I do not doubt the ability and skill with which parabolic mirrors are manufactured in the workshops of the Société Schuckert, nor do I doubt the progress achieved by the Société during the course of 10 years of work. I should like, however, simply to ask M. Nerz if he is prepared to undertake the delivery of parabolic mirrors, of 90cm. diameter, sufficiently exact in form to enable parallel rays coming from an infinite distance to cross one another after reflection within a sphere of 1mm. diameter? If I am well informed, I understand that Société Schuckert, in undertaking a recent supply of mirrors for a neighbouring Power, would not submit to a specification which laid down a dimension smaller than 7mm. for the diameter of the sphere alluded to.

Thirdly, I did not expect that it would be claimed as one of the qualities of the parabolic mirror that it possesses a solidity greater than that of the Mangin. It is of little consequence if a Mangin mirror be thin at its centre. The form of the Mangin mirror is one which offers the most even resistance to strains applied, whereas the parabolic mirror can with difficulty be kept from deformity without being most rigidly mounted, and in such a manner as must of necessity cause most dangerous stresses to be set up by over-heating. M. Nerz asks what experience we are able to oppose to his own. The reply is easy, for Messrs. Sautter, Harlé, et Cie. have delivered up to the present more than 3,000 Mangin mirrors. They do not pretend that none of these have been broken by accident, but, as far as they know, none of them have perished from over-heating or from the concussion of neighbouring guns. Nor have any of them perished from indeterminate causes, as has been the case with 50 per cent. of the parabolic mirrors comparatively recently installed in a fortress not 100 miles from the shores of France. At Toulon I witnessed the refusal of M. Nerz's agents to comply with the request of officers who wished to try a parabolic mirror of 38cm. focal length with a current of over 100 amperes; they feared a dangerous over-heating. M. Nerz's principal weapon of offence in attacking the Mangin mirror has hitherto been the short focal length which can be employed with the parabolic mirror. This weapon he has apparently discarded, or why should the Société Schuckert have abandoned the types of very short focal length, such as those of 90cm. diameter with a focal length of 31cm., which they were constructing some few years ago?

Finally, M. Nerz attaches great importance to the absorption due to the thickness of the glass towards the edges of the Mangin mirror, and he refers to a discrepancy between the figures quoted by M. Blondel in his "Theory" and those recently published by Messrs. Sautter, Harlé, et Cie. I am happy to be able to set his mind at rest on this point by informing him that the coefficient of absorption quoted by M. Blondel, and which was the result of measurements made by me in 1889, has been found from more accurate experiments which I conducted in 1894 to be too high for perfectly-polished glass of the kind from which our Mangin mirrors are made. The actual absorption does not reach one-third of the amount formerly arrived at. This difference has, however, little or no importance when considering the efficiency of the whole mirror, as this will vary scarcely 2 per cent. whichever coefficient be taken. Such a percentage of variation is less than that of the errors made in observation. I have, moreover, actually compared the total absorption of a Mangin mirror with that of a perfectly-polished parabolic mirror of the same diameter, and though contrary to the published statements of M. Nerz, I find that the losses of flux are sensibly the same for both types of reflector.

These are, Sir, the several points which I would wish to lay before such of your readers as may be interested in projectors. It is to be regretted, however, that M. Nerz has thought fit to accuse us of ignoring the teachings of science and of technical experience. We do not do him the same injury, and are quite prepared to continue this discussion, from which he will be able to more seriously study the properties of the Mangin mirror.

SOME USES OF CURVES IN ELECTRICAL PRACTICE.

BY H. H. SIMMONS, A.I.E.E.

The series of articles of which this is the first, is intended for readers having some experience in practical electrical work, but lacking the advantage of training in theory and mathematics. It is intended to familiarise such with the method of representing facts by means of curves, and with the analysis of curves embodying the results of their own or other men's work: we might say, briefly, with the writing and reading of curves.

With this specific object in view no apology will be needed for treating the subject in an elementary manner, and the general lines followed will be simple and easy. It is hoped thus to enable the non-mathematical reader to handle what may be called a part of electrical graphics familiarly, and with a clear and thorough understanding of what he is doing. It must still be admitted that the man who has even a smattering of mathematics has an advantage over him who has not.

The fundamental principle of all curve plotting is in that all simple quantities (known as "scalar quantities") can be adequately represented by the length of a line. Let us take a somewhat absurd but simple illustration. A man is in the habit of ordering goods regularly from some dealer. The goods are of one sort only, and sold in the same way always—say, sugar sold by weight. At last the customer says he will not be bothered to write the order in full each week—the dealer is to understand that a line 1in. long means a pound of sugar, and henceforth he will send postcards with merely a line to represent the amount of sugar. This example may seem puerile, but it is not unnecessary thoroughly to grasp that if that customer sends a postcard with a line 3⅞in. long drawn on it the dealer knows *exactly* what is wanted. The length of a line may be made to adequately represent a quantity. All that is necessary is to arrive at some stated agreement as to what quantity a certain length of line shall mean. This length and this quantity are then our units. It is troublesome to have to measure the length of irregular lines and curved lines, and it is therefore the practice to confine oneself to straight lines for the representation of quantities. The mere possibility of thus even adequately representing a quantity by a length would be of little use, however. It is not until one wishes to represent two connected quantities at one time that the value of this method is apparent.

Let us then see how time and money when connected may be thus at once represented. Taking any point as a datum point, let distance from it—*i.e.*, length—along one straight line mean time; and in order to show money as distinct from, and yet connected with time, let distance from the same point but in a direction at right angles to the other mean money—say, income.

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We have taken two straight lines at right angles as the directions along which we mean to measure for convenience, but, as we shall see later on, it is immaterial what two directions are taken; it cannot be too frequently and clearly insisted upon that the only thing needed is length—everything else is a convenience in method.

With so much agreed upon, it is possible to represent exactly the fluctuations in a man's income. We have but to choose our scale and draw the two straight lines as directions along which we mean to measure. The datum point we will call O, and the two lines along which our measurements are taken O X and O Y, Fig. 1.

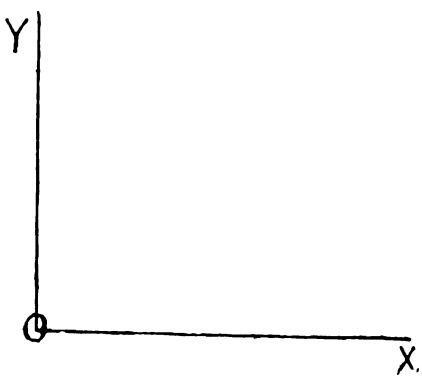

FIG. 1.

These lines, be it remembered, are only *directions*, and purely arbitrary; our convention is to draw them at right angles for convenience, and since they are directions, the actual ink-mark, O X, is only part of an imaginary infinite line. When, therefore, we speak of the direction O X, we may mean to the right or left of O, and possibly right off the paper which contains the actual length, O X.

Along this direction O X we will take length to mean time, and along O Y length shall mean income.

The point O is our datum point from which we have arranged to make our measurements both of time and income. It must, therefore, have a significance in both quantities. A simple meaning in income which we may attach to that point is that of no income at all, so that no distance from O in the direction of O Y means no income. But what are we to do at O with time? If we say let it be when time is O, we must explain what we mean: time = *o* can really have but one meaning—viz., the point of time from which we begin to count. With reference to this particular man, some may urge that in his case time = *o* at the instant of his birth; but does it? To him it does, because he counts existence and time from that point, but there was a time prior to that. Obviously, then, $t = o$ at whatever instant we may choose as that at which we will begin to take observations.

In this man's case we will begin to note his income when he is 16 years old: on the instant of his commencing his seventeenth year of existence.

Let us again state what is our convention, and then choose a scale.

The point O is chosen to mean: first, the point in the man's life—*i.e.*, that point of time—at which he entered on his seventeenth year; second, that point in his income at which his income was nothing; lengths along O X are to mean time, and lengths along O Y to mean income.

Let $\frac{1}{4}$in. along O X mean a month, and 2cm. along O Y mean 5s. a week. If we now measure 2cm. along O Y, Fig. 2, and put a dot, P, to mark the point, that length, 2cm., means 5s. a week; but if this dot is a point connecting income and time—as it must be if it be a point on our curve—what connection has it with time? Time we have agreed to measure from O in the direction O X. Well, our dot, P, has no distance from O in that direction, therefore no time has elapsed. From this we infer that when our young man had completed his sixteenth year (for that is the point of time at O) his income was 5s. a week; in other words, he started at 5s. a week on his sixteenth birthday. Say we are told that at the end of three months he was getting 10s.; to represent this we must find a point at a distance of $\frac{3}{4}$in. from O along O X, and 4cm. from O along O Y. The point *a* is the first and the point 1 the second; but we want *one* point with the properties of these *two* in the above-named respects. This we have in the point P', Fig. 2. For see, the distance P' to 1 is $\frac{3}{4}$in., and it is in the direction O X, and the direction P' *a* is 4cm. from O in the direction O Y. P' is therefore a point on our curve; and if we handed that simple diagram, Fig. 2, with the statement given above respecting O, O X, O Y, and our scale, to a person, that person with a steel rule could tell us as certainly as if we had informed him in so many

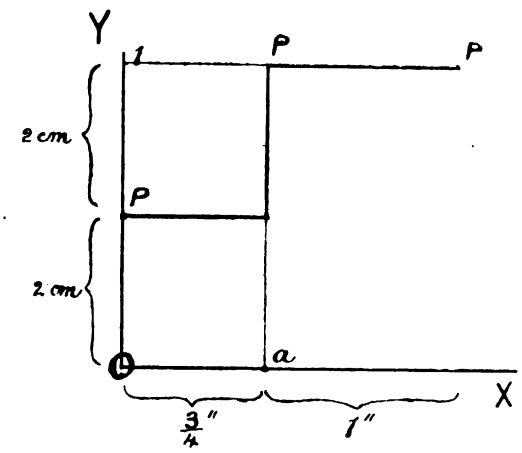

FIG. 2.

words, that the young man started on his sixteenth birthday with 5s. a week and received a 5s. rise in three months. If this line be continued to P" for a length of 1in., he will know that for the next four months he received the same income; but there our curve stops, and beyond that point of time—viz., seven months from the start—gives us no information.

(To be continued.)

CALORIFIC VALUE OF REFUSE.

At the late annual meeting of Municipal Engineers at Halifax a paper was read by Messrs. T. S. McCallum and W. Naylor, the latter part of which gave the results of Mr. Naylor's experiments on the calorific value of the refuse destroyed. These results in some measure differ considerably from those recorded by other experimenters; and as the subject is of importance both to municipalities and to electrical engineers we give that part of the paper relating to this question, as follows:

The trials at the works were made with the help of Mr. McCallum and other assistants on Friday, May 24, for machinery and refuse destructors, and Tuesday, the 28th, for raw sewage and effluent only. The raw sewage was sampled every quarter of an hour from 10 a.m. until 2 p.m. The quantity of sewage treated was 42,250 gallons, to which was added 53lb. of precipitant (ferozone), or 8·8 grains per gallon. This was allowed to settle until 6 p.m. The filters were then put into operation, and were running from 6 o'clock to 6.50, samples also being drawn every 10 minutes. At 6.50 the head of water on the filter had fallen 6·5in., which is equivalent to 30·6 gallons per square yard per 50 minutes, or 880·8 gallons per square yard per 24 hours. The results of this treatment are set out in Table A. This shows that the percentage of reduction brought about is—

	Per cent.
For total solids	16·2
,, albumenoid ammonia	81·5
,, oxygen absorbed	87·8

The composition of the precipitant was:

	Per cent.
Silica	5·75
Moisture (free)	20·09
Ditto (fixed)	12·31
Sulphate of alumina	38·23
Ferrous sulphate	4·03
Lime, magnesia, etc.	19·59
	100·00

The actual amount of sludge produced was not calculated, as this is very variable, according to the quantity of precipitant used and the length of time it has been standing. Its composition, guessed, however, was:

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TABLE A.—Results Expressed in Parts per 100,000.

Nature of sample.	Taken by	Date.	Dissolved solids.			Suspended solids.			Gross solids.			Free ammonia.	Albumenoid ammonia.	Oxygen absorbed.	Chlorine.	Nitrates.
			Mineral.	Volatile.	Total.	Mineral.	Volatile.	Total.	Mineral.	Volatile.	Total.					
Raw sewage	W. Milner	May 28, 1895	50	26	76	14	21	35	64	47	111	2·788	·694	{5 mins., 3·2 / 4 hrs., 8·2}	6·6	0
Tank effluent	W. Milner	,, ,,	51	21	72	5	3	8	56	24	80	2·636	·342	{5 mins., 1·4 / 4 hrs., 4·0}	6·1	0
Filter effluent	W. Milner	,, ,,	64	28	92	0	1	1	64	29	93	1·132	·128	{5 mins., ·8 / 4 hrs., 1·0}	6·0	3·7

	Per cent.	Per cent.
Water	49·23	49·23
Organic matter (including fixed ammonia)	·68	21·66
Silica		9·54
Oxides of iron and alumina		9·89
Phosphoric acid		·514
Lime, magnesia, etc.		9·166
		100·00

Boilers and Destructors.

The trial of boilers and destructors was carried out on the lines suggested in the report of Mr. Michael Longridge, M.I.C.E., for 1887 to the Engine, Boiler, and Employers' Liability Insurance Company. Four furnaces were working from 11.45 a.m. to 5 p.m., or 5¼ hours. The start was made with the hoppers, furnaces, boiler pressure, and water-line at points noted, at which points also the trial was finished. The amount of refuse burned was weighed out in 98lb. lots, and amounted to 9,996lb., or 4·46 tons. The ash and clinker weighed out from this was 4,638lb. (2·07 tons), or 46 per cent. of the input. The self-evident incombustible matter—such as tin cans, etc.—was sorted out from the refuse and not weighed in; but it averages, I am informed, all the year round about 2·2 per cent. of the carted refuse. The water evaporated from this was 3,998lb., or ·40lb. of water per pound of refuse. This was evaporated straight from the filter-beds at a temperature of 58deg. F. Calculating the water evaporated from and at 212deg. F., it would amount to ·46lb. of water per pound of refuse. Now this result appears very low, especially side by side with trials of refuse destructors which have recently been published claiming evaporation of about 2lb. of water per pound of refuse, and it was really this very low result at a preliminary trial which prompted this more careful trial and investigation. The analysis of the refuse as sampled from 102 tins weighed out was:

	Per cent.
Moisture, dried at 212deg. F.	25·3
Volatile matter	28·2
Ash	46·5
	100·0

A sample of the refuse dried contained:	Per cent.
Combustible carbon	11·2
,, hydrogen	·12

The calorific value of the refuse dried, therefore, deducted from this analysis is 1,693 (taking the calorific value of carbon at 14,545 and hydrogen at 53,337), or about one-seventh of good steam coal. Tested practically with a calorimeter, the carbon value of the refuse was so low that combustion even in oxygen mixture was impossible, but mixed with a weighed quantity of coal, the calorific value of which was previously determined and afterwards deducted, the calorific value of the waste was 1,702. It was preferred, however, to take the theoretical figure, as the difference between that and the practical test is represented only by less than one-tenth of a degree on the thermometer, to read which was impossible with the thermometer used.

Determination of calorific value of coal (two grammes coal and 1,934 grammes water taken):

	Deg. F.
Original temperature of water	62·0
Final	74·5
Difference	12·5
Add 10 per cent. for heat retained by copper cylinder	1·25
Calorific value in B.T. units – 13,296·25	13·75

Determination of calorific value of refuse (two grammes coal, two grammes refuse, and 1,934 grammes water taken):

	Deg. F.
Original temperature of water	63·0
Final	77·1
Difference	14·1
Add 10 per cent., as before	1·41
	15·51

Calorific value of total	14,998
,, ,, coal only	13,296
,, ,, refuse	1,702

As the refuse, however, is here calculated dry, and it really contained 25 per cent. of moisture, its calorific value is ·75 (1,693) = 1,269; but even this is not available, for the 25 per cent. of moisture must be evaporated from the refuse representing 1,269 units, at the expense of its own inherent heat, before any work can be got out of it. The temperature of the refuse as fed in was 58deg. F., and the thermal units required to evaporate ·25lb. of water from 58deg. F. at atmospheric pressure $= \frac{1,146-58}{4} = 272$ thermal units. This brings us now to the real value of the refuse—viz., 997 (1,269 – 272) thermal units per pound wet. Let us now look how these 997 units of heat are disposed of.

Heat Lost by Drawn Clinker.—One pound of refuse produced ·46lb. ash and clinker. This clinker was allowed to lie, however, in the ashpits until it reached a temperature of only 500deg. F., and was then wheeled out. The heat given off, therefore, in falling to this temperature would enter the furnaces with the draught. ·46lb. × ·17 (specific heat of clinker) × 442 (500 – 58, number of degrees raised) = 34·5 thermal units.

Heat Lost by Unburnt Carbon in Clinker.—The dry clinker contained 1·8 per cent. of unburnt carbon, which is equivalent to ·008lb. per pound of refuse burnt. ·008 × 14,545 = 116·37 thermal units, also lost.

Heat Lost by Heating of Products of Combustion, Excess Air, and Superheated Vapour.—Samples of the gases drawn from the flues consisted on the average of:

	Per cent.
Carbonic anhydride	4·7
Oxygen	14·5
Nitrogen	80·8
Carbon monoxide	0·0
	100·0

Or, since air contains 21 per cent. oxygen and 79 per cent. nitrogen, we may write it down:

	Per cent.	
Carbonic anhydride	4·7	Products of combustion.
Nitrogen	26·3	
Excess air	69·0	

This result, owing to the nature of the refuse burnt, is very much different to what takes place in a good coal furnace, where the products of combustion are about double the above and the air in excess about half. Now, this excess of air, as well as the products of combustion, must be heated to the exit temperature of the flue, which, as recorded by the thermometer, averaged 356deg. F.

The weight of carbonic anhydride per pound of refuse equals (3·66) × ·075, number of pounds carbon burnt = ·2745lb. $\frac{\cdot2745}{\cdot122} = 2·22$ cubic feet, and since the composition of the gases shows the carbonic anhydride to be 4·7 per cent., the total volume of gases per pound of refuse will be $\frac{2·22 \times 100}{4·7} = 47·2$ cubic feet, and this 47·2 cubic feet will be made up as follows:

	Cubic feet.		Weight per lb.	lb.
Carbonic anhydride	2·22,	or refuse =	2·22 (·1222) =	·2708
Nitrogen	12·4,	,, =	12·4 (·078) =	·9672
Air	32·5,	,, =	32·5 (·081) =	2·6325
Total				3·87.5

To the weight of these gases must also be added that of steam formed by the combustion of the hydrogen in the refuse, which was ·12 per cent. dry. The actual weight would therefore be ·75 (·12) = ·09 per cent. = ·0009 per pound hydrogen, = 9 (·009) = ·008 steam. The 25 per cent. of water in the refuse also, existing as moisture, must be added to the gases, which, of course, as steam would have the same weight—

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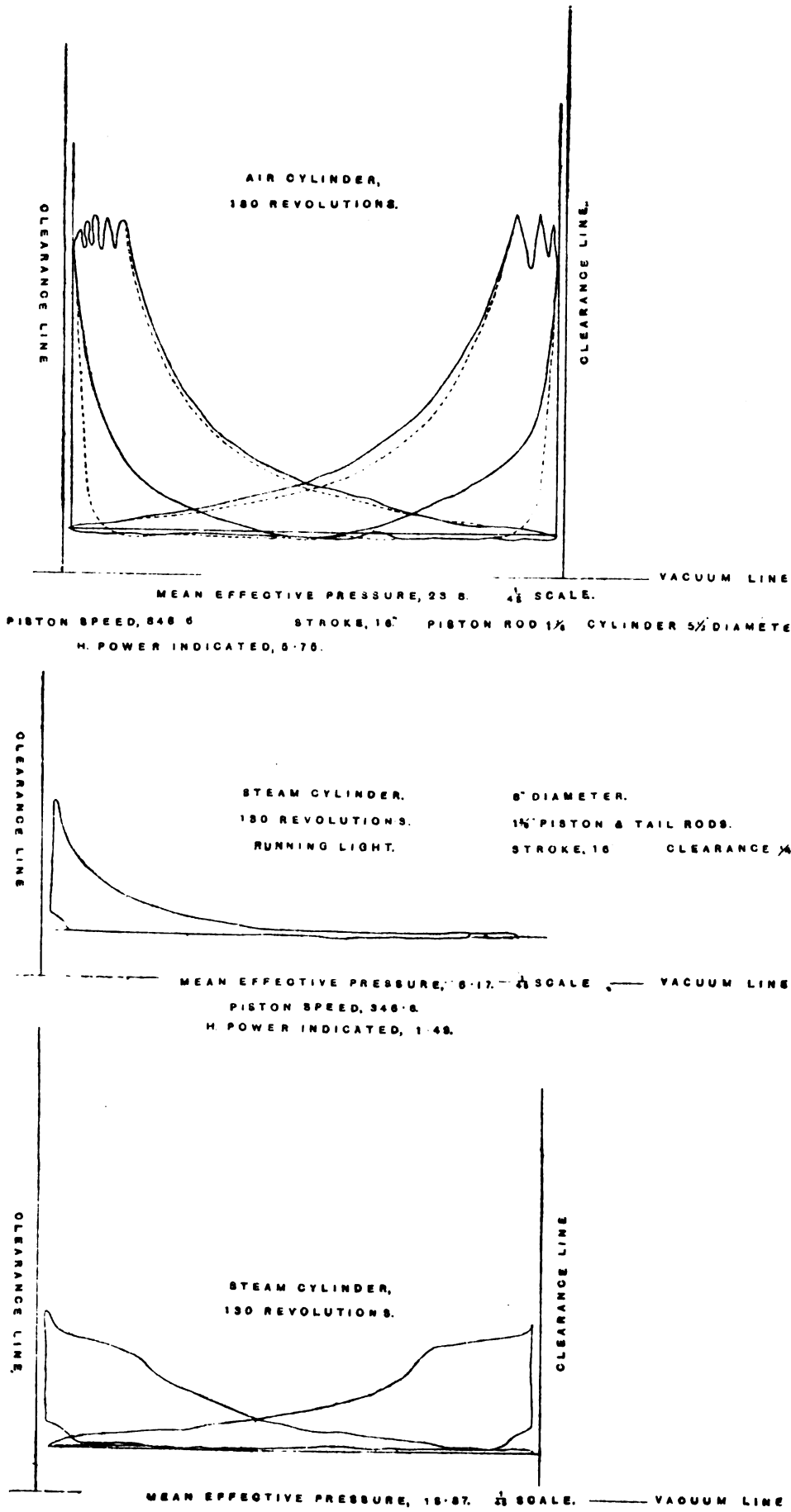
viz., ·25lb.; and, lastly, the aqueous vapour in the atmosphere, which amounted to ·04lb. in the 48·2 cubic feet of air drawn through per pound of refuse. The weight of aqueous vapour in this 48·2 cubic feet of air is corrected for temperature and pressure at the time of the trial.

$$\frac{48\cdot2 \times 29\cdot9 \times (1 + 00\cdot2 \times 76)}{29\cdot02 \text{ actual pressure} - \text{tension aqueous vapour at } 58^\circ \text{ F.} = 52\cdot2.}$$

$$52\cdot2 \times \cdot00077 = \cdot04.$$

From the above calculations the following Table B concerning the heat carried away by the exit gases can be drawn up:

In addition, however, to the calorific value of the refuse calculated as sensible, the heat contained in the entering air, vapour, and fuel must also be added to that which is sensible in the refuse. This is as follows: fuel, 1lb. × ·2 (specific heat) × 26 (number of degrees above zero) = 5 units; air, 2·632lb. × ·238 (specific heat) × 26 = 16·2 units; aqueous vapour, ·04lb. × ·481 (specific heat) × 26 = ·5 unit.


AIR CYLINDER,
180 REVOLUTIONS.
CLEARANCE LINE.
CLEARANCE LINE
VACUUM LINE.
MEAN EFFECTIVE PRESSURE, 23·8. 4/8 SCALE.
PISTON SPEED, 846·6 STROKE, 16" PISTON ROD 1⅛ CYLINDER 5½ DIAMETER
H. POWER INDICATED, 5·76.
STEAM CYLINDER. 8" DIAMETER.
180 REVOLUTIONS. 1⅛" PISTON & TAIL RODS.
RUNNING LIGHT. STROKE, 16 CLEARANCE ¼"
CLEARANCE LINE
MEAN EFFECTIVE PRESSURE, 6·17. 4/8 SCALE. VACUUM LINE
PISTON SPEED, 346·6.
H. POWER INDICATED, 1·48.
STEAM CYLINDER,
130 REVOLUTIONS.
CLEARANCE LINE.
CLEARANCE LINE
MEAN EFFECTIVE PRESSURE, 16·87. 4/8 SCALE. VACUUM LINE
PISTON SPEED, 846·6.
H. POWER INDICATED, 7·10.

Royton Sewage Depot.—Air Compressor Diagrams.

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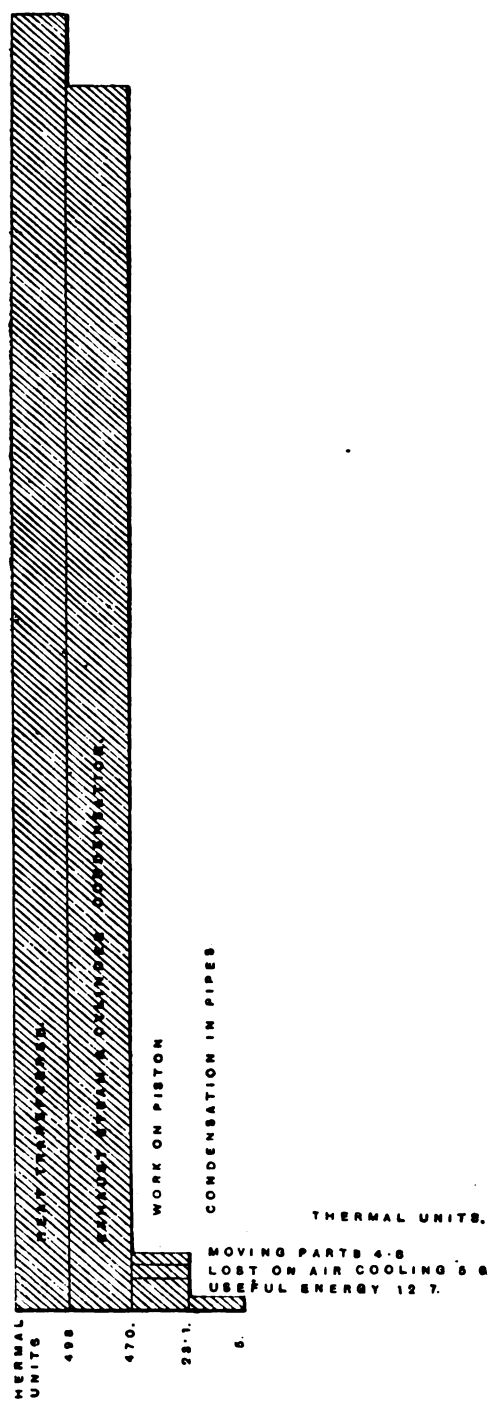
TABLE B.

Name of gas.	Weight of gases.	Specific heat.	Heat capacity.	Number of degrees F. raised.	Thermal units.
Carbonic anhydride	·274	·216	·059	298	17·6
Nitrogen	·967	·244	·236	298	70·3
Air	2·632	·238	·626	298	186·5
Aqueous vapour	·040	·481	·019	298	5·6
Water in refuse	·250	·481	·120	144	17·2
Steam from hydrogen in refuse	·008	·481	·0044	144	·6
				Total	297·8



Royton Sewage Depot.—Heat Transferred to Water from 1lb. Refuse.

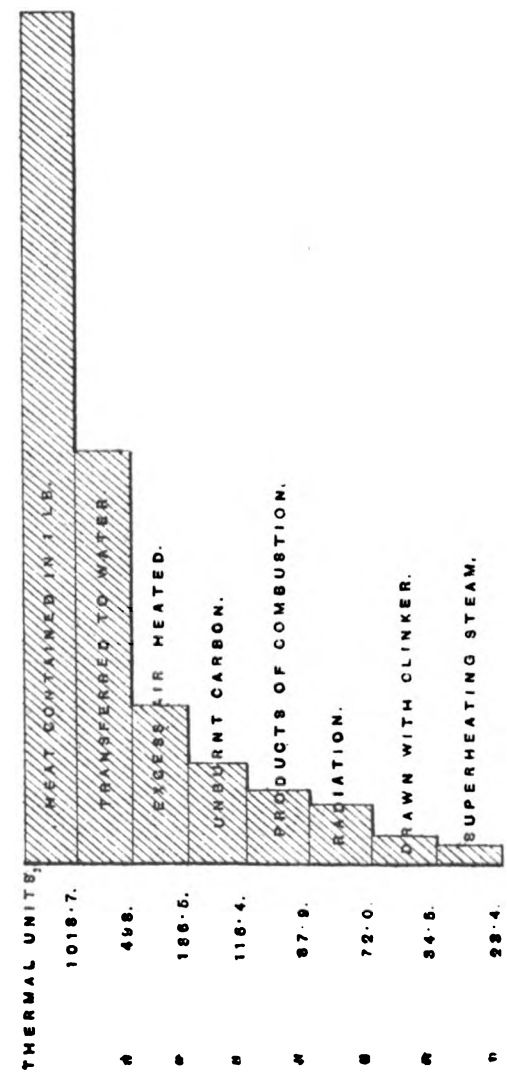
On the above results the following balance-sheet may be drawn out, which shows the loss by radiation and heat not otherwise accounted for to be only 72 thermal units per pound of refuse burnt, or 7·0 per cent.

Dr.	
Calorific value 1lb. wet refuse	997 ·5
Heat in fuel	5
Heat in air	16·2
Heat in vapour	·5
	1,018·7

Cr.		Per cent.
Heat transferred to water	498	48·89
Heat lost by chimney gases—		
Carbonic anhydride	17·6	1·73
Nitrogen	70·3	6·90
Air in excess	186·5	18·31
Heating and superheating vapour	5·6	·55
Superheating moisture in refuse	17·2	1·69
Superheating steam from hydrogen in refuse	·6	·06
Heat lost by drawn clinker	34·5	3·29
Unburnt carbon in clinker	116·4	11·42
Balance, by radiation, etc.	72·0	7·07
	1,018·7	99·91

SLUDGE-PRESSING.

The steam generated was used for sludge-pressing, but it was impossible to run the compressor at a uniform speed throughout



Royton Sewage Depot.—Heat-Disposal Diagram, 1lb. Refuse.

the 5¼ hours from the very nature of the work. But when the condition of the rams permitted it, the compressor was run at its normal speed of 130 revolutions right through the receiver at 100lb. into the rams. When this was not possible, the ram was shut off from the receiver and the latter run up to 100lb. and then opened on to the rams, the falls in pressure being noted as well as the temperatures of the receiver. By this means the amount of air used for sludge pressing could be calculated. The amount of dry sludge turned out by each press averaged 2,025lb., or 18·9cwt., at each pressing, which is equivalent to 150·67cwt. wet, the wet sludge containing 88 per cent. water. To compress this the compressor was running at 130 revolutions right through the receiver at 100lb. for 59 minutes, delivering 257·4 cubic feet of air at 100lb. pressure and 225deg. F. into the rams. This at 58deg. F. measures only 194·6 cubic feet, the reduction on cooling being 24·3 per cent., though, of course, some compression in the ram may have taken place before the whole mass of air had cooled. To this must now be added 62·3 cubic feet turned in from the receiver (in 18·8 minutes), making a total of 256·9 cubic feet for two presses, or 135·9 cubic feet of air required per ton of sludge dry, which is equal to a mean pressure in the ram of 45·51b. From the diagram it will be seen that the compressor was indicating 7·1 h.p. in the steam-cylinder loaded, and 1·49 h.p. light; but the effective horse-power here is not the difference

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between the one and the other, for as the air is not cooled during compression, owing largely to the leakage of hot air, a certain amount of work is afterwards lost when it becomes cooled and the pressure falls in the ram. The diagram which would have been made in the air-cylinder had the air been thoroughly cooled, is represented by the dotted isothermal curve, or, perhaps, it might be termed the cold-air curve. The actual air delivered per stroke at 100lb. and 225deg. F. was only ·02333 cubic feet. It will also be noted here that even the air which was compressed leaked back again from the receiver to some extent, owing to the check-valve being out of repair. This was noted at a preliminary run a few days before this recorded trial and pointed out to the Board, who reported to the authors that the valve had been repaired. It was only after the actual trial had started that the diagram disclosed the fact that it had not been effectually remedied. The curve which the back-pressure line should take is shown by the lower dotted line, allowing ¼in. clearance. An allowance has been made for this leakage in calculating the actual amount of air admitted to the rams, though no deduction was made for the difference in temperature between the discharged air and the air which leaked back.

It would be manifestly unfair, owing to leakage, to refer to the indicated horse-power per hour per ton of wet sludge pressed, or, what is the same thing, per cubic foot of air delivered to the rams at 100lb., for although the slipping air would react on the back stroke, a given volume of slipping air at a given pressure represents really more work than the same volume at the same pressure on the forward stroke, owing to the fall in temperature after delivery. Again, the relation between the light load and working load will be the same whether leakage is going on or not, so that in case leakage does exist, the indicated horse-power per cubic foot delivered will be much higher than in the absence of leakage. Since the air-compressor was not running either uniformly or continually during the 5¼ hours' trial, the quantity of steam used per stroke of the piston could not be measured by the water evaporated. The diagrams, however, show it to be 41·74lb. per hour per indicated horse-power. To this must be added 1 per cent. condensed in the 80ft. length of steam-pipe, including five bends, as recorded by tests made with a globe calorimeter = 42·15lb. The same instrument recorded little or no priming in the boiler, which could only be expected, considering the comparatively low pressure—70lb.—slow consumption, and large dome. To the 42·15lb. must be added 10 per cent. for cylinder condensation, which brings the consumption to 46·36lb. Now, since the boiler evaporation was $\frac{\cdot 4 \times 9996}{5\cdot 25}$ = 639·6lb. per hour, the indicated horse-power possible, had the compressor been working continuously, was 13·7, or 3·4 horse-power per hour per cell. The diagrams also show that the actual work performed on the piston was 224,598 foot-pounds, which are equivalent to 290·9 units of heat per minute. But to do this work the steam consumed per minute was 5·48lb., containing 6,295 units of heat, the difference between the two—viz., 6,004—being lost by radiation, or carried away by the exhaust.

The balance-sheet may now be continued, to show how the 498 units of heat entered as transferred to water are disposed of finally:

Dr.	Thermal units.
Transferred to water from refuse, etc.	498
	498

Cr.	Thermal units.
Lost by condensation in steam-pipes	4·98
Carried away by exhaust steam and radiation	470·0
Converted into work on piston	23·1
	497·98

Of the 23·1 units of heat really converted into work on the piston, 4·8, or 21 per cent., are taken up by the weight of moving parts; and, again, 5·6 units, or 24·3 per cent., are afterwards lost on the cooling of the compressed air, leaving only 12·7 thermal units, or 1·2 per cent., of the refuse value in hand contained as energy in cold air at 100lb. pressure. The accompanying diagrams represent the foregoing analysis.

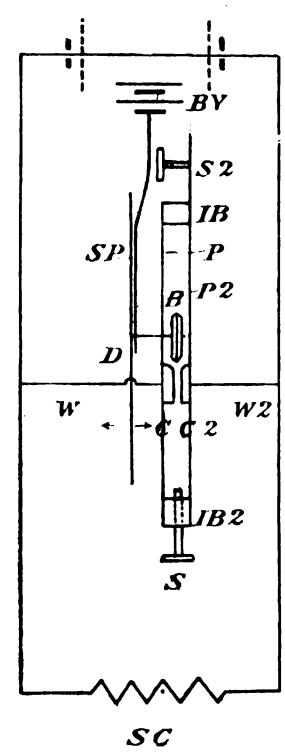
In conclusion, it is desirable to state that this trial is not by any means submitted as a model result, but simply to show what is at present going on at Royton. The authors do not for a moment suggest that the arrangements as described should be followed out by other engineers designing plant for the same purpose. If the results show anything at all they show that the idea of burning town refuse at any sort of profit is erroneous. It cannot be imagined that refuse which gives on evaporation anything less than 2lb. or 3lb. of water per pound of refuse would pay for carting. And what sort of refuse must that be? Certainly not the kind found in Lancashire; and, if not there, where can it be found? In burning town refuse one labours under the disadvantages of: (1) a large percentage of moisture in the refuse; (2) the necessity of heating a large percentage of air in excess in order to get it to burn at all; (3) the loss of considerable heat in the abnormal quantity of ash produced.

The above results point to a calorific value of about 4,000 thermal units to be possessed by town refuse containing the moisture which it usually does to bring about an evaporation of 2lb. of water, and any refuse containing this is practically only half-burnt coal. If any economies are to be effected in the future in the utilisation of town's refuse, the points towards which attention might be profitably concentrated are, as shown by the results here recorded: (1) Reduction of loss of heat owing to evaporation of moisture contained in the refuse. Such reduction will probably be brought about by the utilisation of the exit gases for drying the refuse primarily. (2) Reduction of loss incurred by the heating of excess air. There is certainly no known probability of burning the refuse with a smaller quantity of air, but another mode of economical working is open—viz., that of abstracting from the excess air by means of economisers some portion of that heat which at present it carries away.

But apart from the actual burning of the refuse, greater economies may surely be effected at sewage-disposal works by the adoption of condensing steam-engines, considering the low pressures used and the abundance of cooling water, and again by the retention of the partially-exhausted air, which is at present blown to waste out of the sludge-rams.

TELEPHONE TRANSMITTER.

In this transmitter the direction of the current is changed, as well as varied in strength, without breaking the battery circuit. Will readers interested kindly give their experiences with regard to circuits using this or similar transmitters? Referring to the diagram, D is the section of the diaphragm, S P is a spring connected to one pole of the battery, BY, and fitted to press on D at the centre. S P also carries a carbon or metal bevelled edge button, B, on a stalk, through which the movements of D in the direction of the arrows is transmitted to B. B may be turned round and new surfaces presented to the contacts. P and P_2 are two stiff plates, insulated from one another, and fixed to the insulating blocks, I B and I B_2.



C and C_2 are two carbon contacts, shaped as shown, and electrically connected to the other pole of the battery, BY, as shown. S is a screw by which the contacts, C and C_2, may be made to approach the button B vertically, and S_2 is a screw by which they may be adjusted horizontally. Usually the contacts, C and C_2, are adjusted to make equal contact with B, so that practically equal currents pass through the wires, W and W_2. The vibration of the diaphragm will alter the relative resistances between the contacts C, B, and C_2, and as a result the current through the shunt circuit, S C, will vary in direction as well as in quantity. The circuit through S C may include the receiver of the distant station or the primary of the local transformer. The cells may be arranged in the positions shown by the dotted lines.

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BOUND VOLUMES.

Vol. XIV. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers or binding can be obtained, price 2s.

ELECTRICAL GRAPHICS.

The question of the mathematical treatment of physical problems has been for years an obstacle in the way of many men not blessed with a good mathematical knowledge. It is surprising that many electrical problems, capable of easy solution by simple proportion, should have called forth such a show of integral calculus and differential equations. The practical result has been that certain subjects are practically closed books to many men fully capable of understanding every practical fact about them. To state an example: a certain gentleman designs, say, a wattmeter, and calculates to a tenth per cent. by mathematics the accuracy of its readings and the general truthfulness of his most excellent device; yet the said wattmeter has the audacity to lie persistently behind his back, and turns out to have a large error in certain circuits in spite of the mathematical calculations. On the other hand, it will be rightly urged that the higher mathematics have been of inestimable service in the submarine cable work, and, indeed, in lighting and transmission work; though, as we say, the vast mass of it can be comprehended by those having a moderate mathematical training.

To state the facts concisely, the mathematical man without practice is a drug on the market, while the practical man without a fair knowledge of mathematics is seriously handicapped in his investigation work. It is practically impossible for a business man who has forgotten his elementary algebra, trigonometry, etc., to take up the study of the integral and differential calculus with profit to himself. There remains to him the system of reasoning by the aid of graphic construction and curves. This branch of study so developed and taught at the City and Guilds Institution, is essentially a practical man's tool. A mechanical engineer versed in indicator diagram work and Zeuner's valve diagram will readily pick up the essentials. The advantages of the plotting of curves to record the qualities of dynamos and alternators, etc., has been proved by the universal adoption of the methods in all electrical shops. In fact, this method of curve analysis may be considered to have the following advantages. It forms a ready means of calibrating measuring instruments of all kinds, as it enables faulty readings to be corrected. When used in such cases the error of the instrument can be obtained easily from the curves, and errors in the principle of construction shown. Again, for ascertaining the magnetic properties of iron, the method of plotting the induction and magneto-motive force is the only practical method of gauging minutely the quality of the samples. Even when wattmeter readings are taken to ascertain the hysteresis loss in the iron, the values for different inductions should be plotted to eliminate faulty determinations. In dynamo design, and kindred problems, the analysis by means of curves affords the only sight method in the practical determination of the qualities of the machine, and as such appeals with great force to all those engaged in the industry. The way in which the losses of an armature due to hysteresis

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can be divided from those due to eddy currents is one example of this, and the man taking the subject up will be surprised at the facility offered for superimposing the various effects on one diagram.

We feel, however, that a large proportion of the young men in the profession are not in touch with these simple methods of avoiding higher mathematics. This is being overcome by the spread of technical schools; but many older members of the profession will also, we believe, read with interest the series of articles on this subject which commences in our current number.

COST OF POWER.

A letter from Prof. G. Forbes in our correspondence column raises many points of interest, and we should be glad if the information given in it could be supplemented by more figures. Prof. Forbes states that the aluminium works at Niagara are only charged for their electric energy at the rate of one-eighth of a penny per kilowatt-hour. We assume that the Niagara Falls Power Company expect to make a profit at this figure, but the capital charges alone appear to us to prohibit this. For a well-designed central station in England the first cost per kilowatt output rarely, if ever, has fallen below fifty pounds, even when fairly large units are employed. The alternators at Niagara are of larger output than any in the stations referred to, but the weight per kilowatt as obtained from Prof. Forbes's paper before the Institution of Electrical Engineers is not much less. Again, the large first cost of the works, including the tunnel, would keep up the cost per unit. So, assuming that at Niagara the first cost per kilowatt was as low as thirty pounds, and that the aluminium works took current continuously throughout the year, even then, owing to fluctuations in the resistance, in the pressure, and to periods of recharging, it is not probable that a total of more than seven thousand units could be supplied by one kilowatt of generating machinery. The income at one-eighth of a penny per unit would be $\frac{7,000}{8}$ = 875d. = £3. 12s. 11d. This shows a return of only just over 11 per cent. on the capital outlay of thirty pounds. We should expect this to be all absorbed in works charges, such as labour, repairs, oil, etc., and perhaps depreciation might claim a small surplus. Our assumptions as to load certainly are on the right side, but we should be glad if any errors in the other assumptions can be pointed out.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard.

COST OF POWER.

SIR,—You speak of ⅜d. per kilowatt-hour at Frankfort, and 1½d. at the Isar Works, as being an unprecedently low price for electricity. The price at which the Niagara Falls Power Company supply continuous current to the aluminium works at their required voltage is ⅛d. per kilowatt-hour.—Yours, etc., GEORGE FORBES.

London, W., June 28, 1895.

TRAMWAYS INSTITUTE.

SIR,—Should you find it convenient, I should feel obliged if you would kindly correct the statement which I am reported in your valuable paper to have made at the discussion referring to the different methods of mechanical traction for tramways, which is not quite correctly reported. My statement was that "*steam*" *was the prime motive power*, without which no other secondary motive power for tramway traction (whether electrical, compressed air, gas, or cable traction was used) could be produced. Whether the one or other method could be more advantageously used, depended mostly on local conditions and the traffic requirements. But if a line was to be worked *under the most difficult conditions* as to its position and requirements, that steam, as the most powerful analogue to our railways, would prove to its best advantage. Besides, *steam* could be worked as *economically* as any other kind of traction.—Yours, etc., H. CONRADI.

London, N.W., July 1, 1895.

ELECTRIC METER TRIALS IN PARIS.

SIR,—May we ask you to insert a correction of an error made by you in your last week's issue referring to the Aron meter? You state that the failures in this instrument have been to the extent of 15 per cent. If, however, you will refer to *Bulletin* No. 3 you will find that the failures are stated to have been *15 per mil*, or only 1½ per cent., which we may say is in accordance with our own experience in England, where we find that, amongst the great number of Aron meters in daily use, not more than 1 or 2 per cent. are considered incorrect. We shall thank you if you will kindly give this correction some prominence, as an error of this kind might be very prejudicial to an instrument at present in use all over the world.—Yours faithfully,

THE GENERAL ELECTRIC COMPANY, LIMITED,
(G. Binswanger, Director).

London, E.C., July 2, 1895.

THE TRAMWAYS INSTITUTE DINNER.

The eighth annual dinner of this institute was held at the Holborn Restaurant on Thursday week. Mr. W. J. Carruthers Wain, the president of the institute, was in the chair, and a large number of tramway men were present. It was noteworthy that so few electrical engineers were present, but we predict that year by year the proportion representing electrical undertakings will rapidly increase. After an excellent dinner, the enjoyment of which was only marred by the heat, the long toast list was attacked with surprising vigour. Mr. John Waugh, C.C., proposed "The Houses of Parliament," to which Mr. L. Atherley-Jones, M.P., responded at length. As Mr. Ebbe Smith was not present to take up his duties, another of that extensive guild, Mr. Holroyd Smith, stepped into the breach and proposed "The Local Authorities." He had many good opinions of the gentlemen constituting the local authorities, and welcomed the increasing influence which they had over tramway work. Mr. Smith had fought with these authorities in the old days, but now was ready to work with them to any extent. It came as a rough shock to those not thoroughly versed in the history of tramway work to be immediately afterwards assured by the president that no tramway owned by a local authority had ever been a success. This remark came in respond to the toast of "The Tramways Institute," in which Mr. W. J. Carruthers Wain referred to the great assistance tramways had been in overcoming the overcrowded state of many towns. He estimated that 600 million people annually enjoyed the use of the tramways at present in England. To provide for such a large traffic, he held that personal supervision by skilled men was required, and that a committee of non technical men could not hope to rule a tramway wisely and well. He proceeded to refer to the energy shown by the institute in opposing harmful legislation, which work had been taken up by his council since 1889.

Mr. SELLON, in replying to Mr. Fell, said that he had no intention of disturbing the harmony of the evening by dis-

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cussing the merits of one system of haulage over another. The tramway world had had planted in their midst a baby of great promise. The real author of its being he had never been able to discover, though he did know one or two gentlemen who claimed that honour. Apparently the mother was not quite respectable, for she was never mentioned. Now, when there was so much difference of opinion as to origin there must, he (Mr. Sellon) said, be a considerable difference of opinion as it how it should be nurtured, and the unfortunate infant was shown and trotted out to the admiring gaze of local authorities in such various suits, in taste and out of taste, as perplexing to the public mind as it was fatal to the growth and expansion of its many budding virtues. However, he thought that electricity could now be suitably supplied, and with advantage, as a means of traction for tramways. Like Homocea, it touched the spot, and they had only to give it a fair trial and then many pains and ills would be instantly relieved. Mr. Sellon concluded by thanking Mr. Fell for the kind way in which he had introduced his name into the toast.

DUBLIN TRAMWAYS.

The proposed conversion of a large system of tramways like the Dublin United from horse traction to electric traction, is of such manifest interest to the electrical industry that no apology is necessary to refer again to the question, and to put some points forward which strike us after having more carefully considered the report of the engineer.

In June, 1894, Mr. Hammond read a paper before the Association of Municipal Engineers, after having, as he admits, visited most of the systems in use at home and abroad, including South Staffordshire and Budapest. As regards the latter system, he gives it every praise; he mentions the ease with which it works the extraordinary traffic—sometimes much congested—that it successfully deals with, and he gives it his opinion as follows: "The writer wishes to state his conviction that there are many towns in this country (United Kingdom) where a properly-designed and solidly-constructed conduit system would prove a great success." We venture to suggest that Dublin might very well be one of these towns; at any rate we invite the author of the report to tell us the grounds on which he condemns the conduit and introduces an overhead system with the "objectionable overhead wires" (the words are his own) strongly opposed by the Corporation concerned. Clearly it cannot be on account of any failure in working, because he draws attention to "the excellent results," hampered though the system is by having to adopt a metallic return, which is not required in this country. And we must conclude it is for one or other of the following reasons: (1) expense, (2) drainage, (3) width of slot.

Now, all the advantages claimed by the adoption of electricity *quâ* electricity are equally applicable to either the conduit or overhead. We therefore intend to confine our remarks as to the particular form of application.

Expense.—The cost of an installation must, of course, depend on the local conditions and the paying capacity of the tramway. Just as you could not reasonably be called upon to construct a country tramway as expensively as a tramway in a crowded street, so it would not be reasonable to require an expensive system on a tramway that could only support a more economical one. We repeat, each case must be viewed on the local conditions. We are therefore tempted to ask, Has the Dublin United, with the assistance of Mr. Hammond, made out a case to the Dublin Corporation why they should be permitted to use overhead wires, and, to a certain extent, disfigure one, at least, of the finest streets in this country? We emphatically say, "No!" To prove our point, we think we cannot do better than make a comparison between Pesth and Dublin, the population of both towns being nearly the same. At the present moment the Dublin United pay 5 per cent on their inflated capital, which is equal to about £19,650 per double mile of tramway. The large profits made by somebody in the promotion and construction of the tramways has little to do with the Corporation of Dublin.

Taking Mr. Hammond's lowest figures, that the introduction of electric traction will increase the gross receipts 30 per cent., and the working expenditure at 55 per cent., and applying this to the present earnings of the tramway under consideration, we obtain a gross income of £182,000 a year, at an expenditure of £101,100, leaving a profit of £80,900, which is equal to over 8 per cent. on a capital of £977,000, being the existing capital plus the amount required for an installation on the conduit system of electric traction. We do not contend that larger profits may not be made by a reduction of capital due to the introduction of an overhead system, but this has nothing to do with our argument.

This income is also not extraordinary when it is remembered that the Pesth tramway on a mileage nearly five times less than Dublin makes, in gross receipts, £81,330 and pays 8 per cent. on an historically inflated capital.

Drainage.—Mr. Hammond admits that at Pesth difficulties as regards the drainage of the conduit are not met with so as to interfere with the working of the line, as we all know Pesth lies very low, and the fall to the Danube is exceedingly small. Now, the gradients on the Dublin United are, if anything, better than Pesth, and the natural drainage of the town is into the Liffey, with a much better fall than Pesth. The conditions of drainage, therefore, are as good, or better, than Pesth, and no trouble need be anticipated in this direction.

Width of Slot.—Should the conduit system require a slot of the same width as at Budapest, there might be something in the argument. We cannot believe that even Mr. Hammond, however, will press this point; we give him credit for knowing perfectly well the reason of the wide slot at Pesth, and we must also give him credit for knowing that this reason is not applicable to English conditions, and we suggest to him that he has unintentionally misled the Dublin United directors in this respect. It seems superfluous for us to add that any conduit system put down in this country will conform to all the Board of Trade conditions (of which the width of slot is one), and this without any hindrance to mechanical efficiency.

We cannot conclude without expressing our surprise that the Dublin United directorate should have been so indiscreet, or so ill-advised, as to force the Dublin Corporation to appear in opposition before a parliamentary committee to maintain their undoubted rights. The right to grant overhead wire consents is for the people alone to decide, and any tramway company attempting to override public opinion at the present day will be hoisted by their own petard, and are also playing into the hands of municipalisation and to the detriment of the tramway industry generally.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The general meeting of this institute was held at the Cataract House, Niagara Falls, N.Y., beginning on Tuesday, June 25, and continuing for four days. Among the objects of engineering interest which it was proposed to visit were the new works of the Niagara Falls Power Company, the Niagara Falls Park and River Railway on the Canadian side, the aluminium plant of the Pittsburg Reduction Company, the plant of the Carborundum Company, and the central station of the Niagara Falls and Buffalo Electric Light and Power Company.

The list of papers to be read was as follows:

"The Substitution of Electricity for Steam in Railway Practice" (inaugural address), by the president, Dr. Louis Duncan, of Baltimore.

"Properties of Fuse Metals when Subjected to Short-Circuits," by Walter E. Harrington, of Camden, N.J.

"Location of Grounds in Armatures, Fields, etc.," by Clarence E. Gifford, of Jamestown, N.Y.

"Some Features of Alternating-Current Systems," by Chas. P. Steinmetz, of Schenectady, N.Y.

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"Theory of General Alternating-Current Transformer," by Chas. P. Steinmetz, of Schenectady, N.Y.

"Compounding Dynamos by Armature Reaction," by Elihu Thomson, of Lynn, Mass.

"Existing Commercial Applications of Electrical Power from Niagara Falls," by W. L. R. Emmet, of Schenectady, N.Y.

"Alternating-Current Curves," by Dr. C. E. Emery, of New York.

"Electric Power in Factories," by Prof. Francis B. Crocker, Messrs. Benedikt and Ormsbee, of New York.

"Some Observations on a Direct-Connected 300-kilowatt Monocyclic Alternator," by Profs. Dugald C. Jackson and S. B. Fortenbaugh, of Madison, Wis.

"On Mechanical Models of the Electric Current," by Prof. Brown Ayres, of New Orleans, La.

"On the Cause of Death in Electric Shock," by Albert M. Bleile, M.D., of Columbus, O.

"Long-Distance Power Transmission at 10,000 volts" (the Pomona plant), by George Herbert Winslow, of Pittsburg.

"Notes on the Reconstruction of a Small Central-Station Plant," by Franklin Leonard Pope, of Gt. Barrington, Mass.

"On Rating the Performance of Electric Power Plants and Transmission of Varying Loads," by Prof. Wm. S. Aldrich, of Morgantown, W. Va.

"Work of the Westinghouse Electric and Manufacturing Company for the Cataract Construction Company of New York," by L. B. Stillwell, of Pittsburg.

PRACTICAL NOTES ON DYNAMO CALCULATION.*

BY ALFRED E. WIENER.

(Continued from page 448, Vol. XV.)

Part IV.: Calculations of Magnetising Forces.

Part V.: Calculation of Magnet Winding.—In the preceding sections of this serial, Part I.: Calculation of Armature; Part II.: Calculation of Magnetic Flux; and Part III.: Dimensioning of Field-Magnet Frame, have been treated.

The formulæ and tables thus far given enable the complete design of the armature with its winding and all its details; provide the means of computing the requisite magnetic flux to be set up by the field magnet in order to obtain the required output at the given conditions; and, finally, give the best and most economical dimensions of the field-magnet frame of the machine. To complete the design of a dynamo it therefore only remains to calculate the magnetising force required to produce the necessary magnetic flux, and to find a magnet winding which furnishes the requisite magneto-motive force at the specified increase of the field-magnet temperature.

As time does not permit the full treatment of the remaining portion in the columns of the *Electrical World*, the reprint in book form of this serial being in the hands of the W. J. Johnston Company now, the application of the formulæ and tables already given, together with that of the parts not yet published, are, in the following, shown by means of a practical example.

Part VI.: Practical Examples of Dynamo Calculation.—From the numerous cases considered in Part VI. the following may be selected: To design a 300-kilowatt bipolar horseshoe-type dynamo, Edison type, to give 500 volts and 600 amperes at a speed of 400 revolutions per minute. Armature to be a smooth drum; magnets to be of wrought iron, and to have a shunt winding producing a rise of 20deg. C. in field-coil temperature.

I. *Calculation of Armature:* (1) *Length of Armature Conductor.*—In bipolar horseshoe type dynamos not having a pole bushing or pole bridges the percentage of effective armature circumference varies from 67 to 80 per cent., corresponding to a polar arc of from 60deg. to 72deg. respectively. In the present example, which is about the limit, in output, to which a bipolar design can yet be carried, the upper limit of $\beta = 80$ can safely be taken for the ratio of polar embrace; for it follows from Table XV. that the height of the winding space, and, therefore, the length of the air-gaps, increases in a very much smaller ratio than the diameter of the armature, in consequence of which a greater percentage of polar arc in a large-diameter armature will yet produce a higher ratio of distance between pole corners to length of gap spaces (see Table XLVII.) than a small percentage will in a small-size armature.

For $\beta = 80$, Table II. gives the value of $v = 013$ for the unit armature induction. Consulting Table III. and Table IV., we obtain the conductor velocity and the field density best adapted for the case under consideration:

From Table III.: $S = 50$ft. per second.

From Table IV.: $\mathfrak{B} = 30{,}000$ lines of force per square inch.

The total E.M.F. that has to be generated in the armature in order to give an output E.M.F. of 500 volts, by Table VI. is:

$$E = e + 03 \times e = 1\,03 \times 500 = 515 \text{ volts.}$$

By means of formula (3) we can now at once obtain the length of active conductor for the armature—viz.:

$$L_a = \frac{20{,}000 \times 515}{013 \times 50 \times 30{,}000} = 530\text{ft.}$$

2. *Area of Armature Conductor and Selection of Wire.*—From (4) the cross-section of the armature conductor is found

$$\delta_a{}^2 = 300 \times 600 = 180{,}000 \text{ circular mils.}$$

Taking three cables made up of seven No. 13 B.W.G. wires, having 095in. diameter and 9,025cm. area each, we have a total actual cross-section of $3 \times 7 \times 9{,}025 = 189{,}525$cm. the excess amply allowing for the difference between the current output and the total current generated in the armature.

A cable is preferable in case of a large machine carrying a heavy current, on account of the better ventilation effected by air circulation in the spaces between the single wires as well as between the cables.

In accordance with Chapter 10, a single covering of 007in. is selected for the single wires, and an additional double coating of 016in. is chosen for each cable of seven wires; making the total diameter of the insulated cable (see Fig. 136),

$$\delta'_a = 3 \times (095'' + 007'') + 016'' = 322''.$$

3. *Diameter of Armature Core.*—The diameter of the armature core is obtained from the mean winding diameter, formula (6), by means of Table VII.

From (6): $$d'_a = 230 \times \frac{50}{400} = 28\,75\text{in.}$$

From Table VII.: $d_a = 97 \times 28{\cdot}75 = 28$in.

4. *Length of Armature Core.*—The number of cables per layer, from formula (9) and Table XIV., is:

$$o = \frac{28 \times \pi \times (1 - 08)}{322} = \frac{87{\cdot}965 \times 92}{322} = 252;$$

the number of layers, from formula (11) and Table XV.:

$$u = \frac{8'' - 5/32''}{322} = 2.$$

Length of core, from formula (12), three cables being in parallel ($p = 3$):

$$l_a = \frac{\frac{12 \times 530}{252 \times 2}}{3} = \frac{12 \times 530}{116} = 38\text{in.}$$

5. *Arrangement of Armature Winding.*—Number of commutator bars, from Table XVI and formula (15):

$$n > \frac{500 \times 2}{20} < \frac{500 \times 2}{10}; \text{ or } n_{min} = 50, \text{ and } n_{max} = 100.$$

Actual number of armature coils: $n = \frac{252 \times 2}{3} \div 2 = 84.$

Difference of potential between two adjacent bars:

$$\frac{500 \times 2}{84} = 11{\cdot}9 \text{ volts.}$$

Number of turns per coil, by (17): $m = \frac{252 \times 2}{2 \times 84 \times 3} = 1.$

The armature winding, therefore, consists of 84 coils,

* From the *Electrical World* (New York).

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each consisting of one turn of three cables made up of seven No. 13 B.W.G. wires.

One armature division, containing the beginning of one coil and the end of the one diametrically opposite, is shown in Fig. 137.

6. *Weight of Armature Winding.*—The total length of armature conductor, from formula (21) is:

$$L_t = 530 \times \left(1 + 1{\cdot}4 \times \frac{28}{38}\right) = 1{,}075\text{ft.}$$

Total length of wire, bare, from (2) and wire-gauge table:

$$l\,b_a = 1{,}075 \times 21 \times {\cdot}02732 = 620\text{lb.}$$

Total weight covered, formula (29) and Table XXI.:

$$l\,b'_a = 1\,031 \times 620 = 640\text{lb.}$$

(To be continued.)

A METHOD OF ELECTRIC TRACTION FOR TRAMWAYS IN TOWNS—THE THWAITE-CAWLEY SYSTEM.*

BY GEORGE CAWLEY.

(Concluded from page 746, Vol. XV.)

This is, no doubt, a somewhat jaundiced view of the working of the conduit system in America, and is not given here as representing a fair statement of up-to-date experience, but it is useful in the way of pointing out a substantial defect in conduit plant erected up to the present time—namely, that the conduit is usually too small either to be properly self-cleansing in respect of the mud and water which will find its way through the slot, or to allow examination or repairs to be easily and effectively carried out within it. This defect has primarily arisen from the view that designers of conduit systems have had of the office of the culvert. They looked upon it simply as a convenient location below ground for erecting naked electric mains from which the current could be conveyed by a suitably-arranged conductor passing through the culvert slot to the motor or motors affixed to the cars. With this view, the culvert has been usually made of puny dimensions, and its accessibility for cleaning and repairs has, as a consequence, been impaired, and its efficiency as an important factor in a system been greatly reduced. Owing, then, to the practical difficulties which seemed to stand in the way of economical working of the conduit system, and to considerations of first cost per mile of track, American tramway companies were led to devote their attention chiefly to the single-trolley overhead system, largely because of its initial cheapness, and, further, because the peculiar expansiveness of American freedom relieved them of any thought-of opposition to the system such as would probably be exercised here by our local authorities.

As constructed in America, the single-trolley overhead system takes a shape which may be briefly described as follows: From the generating station the current is supplied at a pressure of usually 500 volts to the motors on the cars through the medium of a bare copper wire, usually about ½in. in diameter, suspended centrally over each line of rails, at about 19ft. above the ground level. This overhead wire is supported at suitable intervals by ingeniously contrived insulators, affixed to wooden or iron posts, and the current is collected from it by means of a trolley wheel and a thin steel tube, mounted upon a spring frame fastened to the top of the car. From this the current is further conveyed by an insulated wire to the controlling and reversing apparatus and to the motors beneath the cars. After the current has done duty in the motors, it passes therefrom to the iron frame of the car, and thence to the rails, which mainly form the return circuit. The overhead conductor is divided into sections of a quarter or half mile in length, insulated from each other, and the current is supplied thereto from the generating station by separate insulated feeders.

Whether these feeders and the sectional conductors, with their supporting poles, are any detriment to the beauty of the thoroughfares along which they are erected, or any real danger to the pedestrian public, is largely a question of personal taste and opinion, but a people who have allowed an overhead railway to be erected and worked in the main street of their commercial capital are not likely to be over-squeamish about such trifles as would probably upset the equanimity of our local rulers here—who are bound, in virtue of their public positions, to pay very considerable attention to the rights of property, and to the view which our English law takes of the sacredness of vested interests. During what may be termed the experimental stage of the single-trolley overhead system in America, the tramway companies made free with other people's property in a manner which would probably bring ruin on a similar company doing likewise in this country.

At the first, it was thought by American electrical engineers that a return circuit could be mainly established through the earth by well earthing the negative poles of the dynamos, but a heavy coal bill soon indicated that a large percentage of electric energy was being lost in transmission. To remedy this, the rails were connected at intervals to the water and gas pipes along the line of route; but this was found to set up an electrolytic action on the pipes, causing serious pitting and corrosion. The condition of things thus became so alarming, that one gas company official is stated to have described the danger as "akin to sitting on the top of a volcano."

This very serious action on the buried pipes could not be permanently allowed even in America, and it was seen that it would be necessary to provide an independent and efficient metallic return circuit, either by means of the rails or by special return conductors taking the whole return current or acting supplementarily to the rails. It is in this direction that recent improvements have largely been made. Where the rails are used as the sole return circuit, great attention is now given to the efficient "bonding" of the rails joints, by specially designed "rail bonds" formed of copper, and inserted in the vertical web of the rails in the most effective manner that the conditions will allow, or by welding the ends of the rails together into one continuous length.

The difficulties arising out of the return circuit in connection with the single-trolley system provides the chief, or perhaps the only, argument for the existence of the double-trolley overhead system, which has been erected to a relatively small extent in America. While the latter system, if properly carried out, ensures an independent metallic return insulated from the earth, and having a low resistance, it must necessarily be highly complex, especially where the tramway route is much curved, and is, therefore, not well adapted to the serpentine course of many streets in our old towns, even if the overhead system of electric traction were permitted at all.

Having regard, then, to the general requirements of British tramway traffic, and to the opposition which many of our local authorities would undoubtedly give to the overhead system in towns, we may not unreasonably conclude that some form or other of the conduit system is the one most likely to be adopted for electrical traction on British urban tramways, and it will, therefore, be well to proceed at once to generally describe the conduit system which forms the special subject of this paper.

In passing, it may be of some interest to explain that the system of electrical traction to which I am about to refer is applicable to canal as well as to tramway haulage. It contains one special feature, which so far as I know, differentiates it from any other system of electric haulage, and makes it equivalent to horse traction as regards mode of operation. That is to say, it can be applied to an ordinary canal boat or tramcar without making the slightest alteration or addition to the boat or car. In the case of the boat, the haulage force, derived from electric energy, is applied directly to the tow-line, and in the case of the car to the drawbar. As we are simply concerned with the tramcar haulage at present, it will not be necessary to refer further to the application of the system to canal traffic, except I may state here that certain figures have been placed before one of our leading canal companies, showing the relative cost of horse haulage and electric haulage by this system under fairly long-distance traffic conditions, and these figures show the present horse haulage to roundly cost three times that estimated for this electric system, which has also the advantage of leaving the towing path open for horse haulage should that be required.

The special feature of this system, to which reference has been made, which enables the present tramway rolling-stock to be utilised for electric haulage without alteration, is one which may contain considerable advantage. All other electric systems, whether of the overhead, conduit, or storage battery kind, necessitate at least the placing of a motor or motors and controlling apparatus upon the car, the strengthening or replacing of the car underframes, and the laying down of heavier track rails to accommodate the increased weight put upon the wheels. In the case of the storage battery system, especially, the question of relative weight upon the car wheels to unit passenger carried is a serious one as regards the initial cost of the rail track and its upkeep. If, therefore, the weight per car wheel, with electric haulage, can be kept as low per passenger carried as is usual in horse-haulage cars, it will be conceded, I think, that some improvement on existing electrical methods has been attained.

The "dummy" and car are coupled together. The "dummy" is usually carried upon three wheels—a pair of wheels running upon the tram rails, and a centre wheel with a double tread and centre flange running upon the slot girders. It may be carried on four wheels where the nature of the curves offers no difficulty. The "dummy" is driven by a flat bar passing upwards through the slot, and affixed to the hauling locomotive in the culvert, and is attached by a short link or special connecting piece to the ordinary spring drawbar of the

* Paper read before the Tramways Institute of Great Britain and Ireland.

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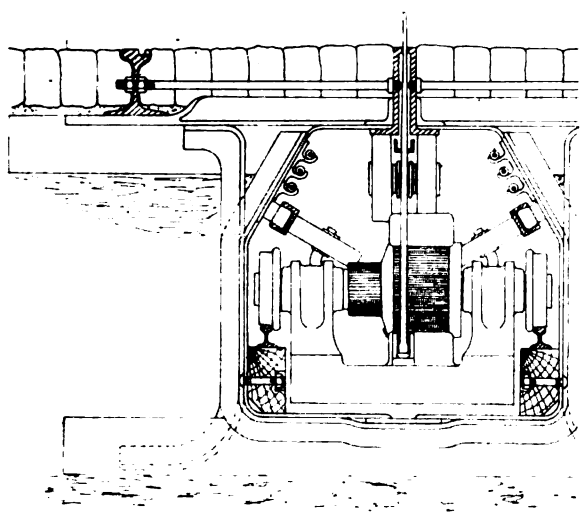
tramcar. The "dummy" is provided with a roof and windows to protect the driver during rainy or cold weather, and also carries the switches, rheostat, and other controlling apparatus required for regulating the locomotive running below it, together with the hand-brake lever and spindle for stopping the car. The current is conveyed to and from the "dummy" by insulated flat strips of copper embedded in the driving-bar passing through the slot. The culvert, as shown in the diagram, is 2ft. 9in. wide and 2ft. 6in. high. It is therefore large enough for a man to get freely along it for the purposes of examination and repairs, especially if he reclines upon a small light inspector's trolley running upon the culvert rails, which he could easily push along with his hands by placing them against the side of the culvert. This facility for examination of the culvert and its fittings is so far peculiar to this system, and I venture to think it will be found an important feature.

The culvert may be constructed with the floor and sides of brickwork or concrete, or entirely of cast iron, wrought iron, or steel. As shown on the diagram, it is intended to be constructed of either of the last two named materials. The materials and mode of construction of the culvert will, of course, vary to suit the particular conditions of each case, as, for instance, the nature and weight of the street traffic passing above it. Assuming the culvert to be made of wrought-iron or steel plates and rolled sections, as shown on the diagram, it could be riveted up into convenient lengths of, say, 12ft., with angles at the ends for bolting the lengths together after being laid in position between the line of rails.



At every 300ft. or 500ft. along the culvert—according to the gradient of the line—mud receptacles or wells are placed, having a manhole between the two lines leading into them, and covered by a chequered-iron flap at the street level. Into these wells any mud, dust, or water falling into the culvert through the slot will be swept by the brush attached to the culvert locomotive. The mud deposited in these wells can be lifted out when necessary, or the wells can be connected with the road sewer by a trapped pipe, and occasionally flushed out by a hose. The well manholes serve as entrances to the culvert when examination or repairs are necessary.

The slot in the culvert is $\frac{5}{8}$in. wide, and accommodates a driving-bar 9-16in. thick. The two girders forming the slot are kept equidistant and rigid by tie-bolts connected to the webs of the tram rails, and also by angles riveted to the culvert plates, and embedded into the concrete forming the culvert foundation. The amount of stiffening given to the slot girders is regulated, of course, by the weight of the street traffic above. Longitudinal sleepers of wood rest upon the floor of the culvert and are bolted to its sides. To these sleepers are spiked hard-steel flat-bottomed rails, having a weight of about 27lb. per yard. Along the sloped roof of the culvert are placed notched supports at suitable intervals for carrying insulated feeders. The return circuit can be arranged by an insulated conductor with feeders exactly similar to the conductor carrying the high-potential current from the power station to the motors. These conductors are made of a dovetailed section of channel iron of sufficient area to keep down the resistance within proper limits, having regard to the maximum current required. The conductors are held in position by porcelain insulators bolted to the roof of the culvert, but are free to move longitudinally to allow for expansion or contraction due to the variations of temperature. Each rigid length of conductor is separated by an arranged distance from the adjoining rigid lengths, but electrically connected by bow-shaped strips of copper. The outward and return circuits can be arranged into quarter or half mile sectional lengths insulated from each other, and provided with separate feeders.

The current—say at a pressure of 500 volts—can be conveyed to and from the motors by a pair of trolley wheels—or by a single trolley wheel, where the return circuit is made through the rails—running along the conductors, and kept in contact by means of a spring. Or, as an alternative, the circuit connection between the culvert conductors and the motors can be made by means of a slider or tongue-piece, arranged to slide along the conductor. The trolley wheel method has been successfully applied in America, and should be found even more successful in this case, as the conductor is a rigid bar.

Attached to the upper part of the culvert locomotive is a lever carrying a pair of wheels which run against the lower flange of the slot girders. These wheels press upwards on their rail bed with a force in some arranged degree proportional to the tractive effort required to haul the car. Therefore, when starting the car, or when the car is mounting a gradient, a considerable downward force is thrown upon the locomotive wheels, in addition to that due to gravity, and their tractive capacity is thereby increased. In order that this downward force may be kept within safe limits, the fulcrum of the lever carrying the upper pair of wheels is made to rest upon a kind of spring buffer-head, which yields when a certain prearranged load is put upon the wheels, and in that way any undue strain on the lever or culvert is prevented.

As the upper surface of the rails within the culvert is some distance above the culvert bottom, the haulage locomotive can be partly located below the rail level, and consequently much smaller driving wheels can be used than where the motor armatures are mounted on the car axles, as is usually done when gearless motors are used. The adoption of these small driving wheels permits the motors to run at a higher speed, and to give a greater commercial efficiency than would be conveniently possible with a gearless motor affixed in the ordinary way to the tramcar axles. In the diagram of the wheels which were shown, the scale was slightly under 8in. diameter, or exactly 2ft. in circumference. With this size of driving wheel, when the tramcar travels eight miles an hour, the motor will run at not less than 352 revolutions per minute, and at 12 miles an hour 528 revolutions per minute, which may be considered a fairly satisfactory speed for a directly-connected motor.

The two motors attached to the culvert locomotive have a tractive capacity of 16 h.p., and are capable of giving a sufficiently rapid start to a tramcar carrying 44 passengers on a fairly level line. The method of regulating the motors is similar to that now commonly employed in American practice. The motors are arranged for series-parallel working, so that when getting the car in motion, after a stop, the current may be dynamically utilised as far as the conditions of working will allow. The speed of the tramcar, when either descending a gradient or travelling along any given route, may be limited to a certain prearranged maximum rate by a special governor.

It may be well, before concluding, to briefly allude to the question of constructive and working cost, for this is the crucial question, with regard to which alone the scheme must stand or fall. Dr. Preller's opinion has been already quoted to show that even with the present puny culverts the conduit system will cost at least £10,000 per mile of single line and upwards. From an approximate estimate made for this system on the assumption that the laying of the culvert is not materially interfered with by buried pipes, the cost of construction per mile of single line complete—including paving, the tramway rails, and the concrete rail bed—comes out at about £12,000, of which about half is for the culvert proper. The constructive cost will, of course, vary with local conditions, but where no special road difficulties come in this system could, no doubt, be laid down for the figure named, exclusive of the culvert locomotives, power station, "dummies," and passenger cars.

In connection with the cost of the latter items it should be mentioned that the dummy cars may, if desired, be left out, as the motor-controlling and brake-regulating apparatus can be placed on the end of the passenger car, and the driving-bar, passing up through the culvert slot, connected directly to the drawbar of the car.

As to the working expenses under this system, I venture to think that they would be found relatively very low for several reasons, among which are fewness of repairs and facility for carrying them out, and the reduction of electric "leakage," and consequent waste of energy.

I will now conclude by asking you to accept my thanks for your kind attention, and with a brief recital of some of the advantages which I think may be reasonably claimed for this system.

(1) The culvert is of sufficient dimensions to allow examination or repairs of the conductors or culvert track to be efficiently carried out.

(2) The culvert can be kept quite free from water, mud, or dust by a brush attached to the culvert locomotive.

(3) The locomotive rails being laid inside the culvert the tractive efficiency of the driving wheels is not affected by snow or frost.

(4) When the culvert is once laid, the street traffic need not be afterwards disturbed, except at long-period intervals for the replacement of the tram-line rails.

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(5) Ordinary horse-hauled tramcars can be used without any structural alterations.

(6) The electromotors used are gearless, and yet run at a relatively high speed and efficiency.

(7) All sparking above the street-level is completely prevented.

(8) All danger to the pedestrian public in the way of accidental electric shocks is entirely obviated.

(9) Posts or other erections along the tramway route are unnecessary, and the appearance of the tramway thoroughfare is not affected.

(10) The tramway rails as used for horse-hauled cars need not be replaced by rails of heavier section.

(11) The system can be conveniently worked in connection with suburban lines using either horse or electric traction.

(12) The load on the driving wheels of the culvert locomotive is proportional to the traction requirements of the car.

(13) The outward and return circuits can be entirely insulated from the earth or buried pipes, thereby preventing any destructive electrolytic action on outside property.

(14) The system in general design is of a character to reduce the cost of repairs to a minimum, and to ensure the durability of the plant over a long period of years.

THE DOVER ELECTRICITY SUPPLY COMPANY'S STATION.

On July 3 the Society of Engineers visited the electricity supply company's station at Dover.

The entrance to the lighting station is by a private road leading from Park-street. The building consists of offices, occupying the west portion, and adjoining these are the engine and boiler rooms. The engine-room, which is faced with glazed bricks throughout, is 100ft. in length by 30ft. in width; the boiler-room is 100ft. long by 45ft. wide.

The engine-room contains the main engines and dynamos, which at present are two 100, one 75, and one 50 kilowatt Mordey alternators, each coupled direct, through a flexible coupling, to Raworth vertical compound-condensing engines, in which forced lubrication is adopted. The alternator bearings are lubricated by means of force pumps. Each main generating unit is controlled by a switch-pillar containing, besides the necessary voltmeters and ammeters, the armature, field, and synchroniser switches, which are interlocking. These switch-pillars throw the alternators on to the omnibus mains which run to the circuit-board through the recording and other instruments. There is at present provision on this circuit-board for six circuits, two of which are for the control of public arc lamps, the remainder being for private lighting. Each circuit is provided with double-pole quick-break switches, fuses, and ammeter. Situated on one side of the engine-room are two continuous-current dynamos, coupled direct to vertical compound tandem engines. These machines feed on to omnibus mains from which the alternator fields are excited. The engine-room also contains two Tangye's centrifugal pumps, coupled direct to vertical engines, which draw water from the River Dour at a point about 100 yards distant, for use in the condensers, attached one to each of the main engines. The pumps draw their supply through two 12in. pipes, forming a duplicate suction, and also discharge into duplicate 12in. mains. A basin has been built in the river bed at a point where the suction pipes draw their supply. All the engines are supplied with steam from a ring main, situated in the boiler-room, and drained by a McDougall steam trap. The floor of the engine-room is about 5ft. above the level of the road. Machinery can thus be readily lifted from wagons by means of a 15-ton crane which traverses the engine-room.

The boiler-room, which is on the road level, now contains two Babcock and Wilcox boilers, each of 200 h.p., working at 150lb. pressure, with space and foundations for five more of the same size. The flue extends along one side of the boiler-room, passes under the front of the buildings, and terminates in a handsome circular chimney shaft 120ft. in height. A Green's economiser of 128 tubes, the scrapers of which are driven by an alternating-current motor, is employed for heating the feed water, which is drawn by two three-throw feed-pipes, either from a well sunk in the boiler-room, or from the tank receiving the condensed water from the main engines, and which can be further heated by the exhaust steam from the auxiliary engines. The feed-pipes are also arranged so that the pumps can deliver water direct into the boilers without its passing through the economiser. The boiler-room also contains a water-meter and a measuring-tank. The engine and boiler rooms are lighted and ventilated from the roof, so as to avoid side windows, and thus reduce any sound to a minimum.

The supply leaves the station at a pressure of 2,000 volts, by Silvertown concentric cables, to some 18 transformer street boxes in various parts of the town, where the current is converted to a pressure of 100 volts and distributed by means of Prescot paper-insulated mains to consumers' premises. There are at present 21 public arc lamps in the streets, each of 2,000 nominal candle-power, and 10 further lamps have been contracted for, to be suspended from arches.

The contract for the whole of the machinery has been, and is being, carried out by the Brush Electrical Engineering Company, Limited. The engineer and manager is Mr. A. J. Lawson. The resident engineer is Mr. A. A. Whitlock.

PHYSICAL SOCIETY.

At the ordinary meeting on June 28, 1895, Dr. Gladstone, vice-president, in the chair,

Mr. Bowden read a note on "**An Electromagnetic Effect.**" A long glass tube, containing mercury and fitted with a small stand-pipe to indicate the hydrostatic pressure, is passed between the poles of an electromagnet. On passing a current of about 30 amperes through the mercury in this tube, the stand-pipe being turned so as to indicate the pressure either perpendicular or parallel to the lines of force of the field of the electromagnet, movements of the mercury in the stand-pipe take place. When the stand-pipe is perpendicular to the lines of force of the field, the mercury rises or falls according to the direction of the current. When the stand-pipe, however, is parallel to the lines of force, the mercury always rises, whatever the direction of the current.

Prof. S. P. Thompson said there appeared to be three unexplained effects—one proportional to the current and the field and reversible, another independent of the direction of the current or of the field, and a third, which only occurred while the current was changing in strength. In addition, there might be a fourth effect, which up to then had not been noticed. The motion of the mercury column was in the opposite direction to that of the drag on the conductor carrying the current. An apparent rise in pressure might be due to a decrease in the density of the mercury, due to the heat developed by the current.

Mr. Blakesley asked if the author had noticed any changes in level in the mercury reservoirs at the ends of the tube.

The **Author**, in his reply, said the reservoirs at the ends were so large that no changes of levels were appreciable

Mr. Rhodes read a paper on "**The Armature Reaction in a Single-Phase Alternating-Current Machine.**" In this paper the author gives the investigations that were the subject of a verbal addendum to a paper read before the society on a previous occasion. He investigates the lag or lead of the E.M.F.'s over the current, and applies the results to examine whether the field excitation of the generator or the motor is strengthened or weakened by the reaction of the armature currents.

Mr. Tunzelmann expressed a hope that the author would amplify parts of his paper.

Mr. Blakesley said the conclusion of the author that "either of two alternate-current machines may be driven as a motor by the other irrespective of their relative E.M.F.'s," is not invariably correct. The facts of the case were these: the E.M.F. of the motor may exceed that of the other machine to a certain extent, but that E.M.F. multiplied by the cosine of the angle of electric lag must yield a product not greater than the E.M.F. of the generator—*i e*, using Mr. Rhodes's symbols, $e \cos \theta$ must not be greater than E. Mr. Blakesley gave a geometrical proof of this, but the same proposition had been given by him some ten years ago in the course of investigating the subject generally. That was at a time when Dr. John Hopkinson was, with less than his usual perspicuity, teaching that synchronous alternate-current machines could not be run in series with stability, both doing work. Referring to the author's diagrams, Mr. Blakesley said that in a problem involving so many elements as that under consideration, it was impossible with the limited dimensions of space to represent the results with the complete generality of a formula. Some elements had to be taken as the independent, others as the dependent variables. The author had considered the power transmitted to the motor, the E.M.F. of the generator, and the angle of electric lag as independent. The E.M.F. of the motor was dependent. In Mr. Blakesley's original diagrams the E.M.F.'s were both considered independent, as well as the electric lag, and the powers applied or transmitted as dependent variables. In any case the formulæ properly derived from such diagrams became perfectly general, and it did not appear to him that the change of method indicated could properly be called a new theory on the subject. As a matter of fact, diagrams based on the independence of the E.M.F.'s and the electric lag would furnish a better means of discussing the question of the stability of the motion than Mr. Rhodes's plan, and this might account for the entire omission from the paper of this important matter.

Prof. S. P. Thompson said it was impossible to discuss the question of stability till the subject of armature reaction had been thoroughly investigated. The terms "lag" and "lead" had been used by Mr. Rhodes in a consistent manner, but this was not always done, and he recommended that the phase of the current which was common to both generator and motor be taken as the standard.

The **Author**, in his reply, said he agreed with Mr. Blakesley that there was a limit to the extent to which the motor might be excited, and this upper limit could easily be obtained from the figure given in the paper. The question of armature reaction was, however, most important, as it might excite the field two or three times more than the original excitation. Since motors were

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designed to do a certain amount of work, and not the work to fit the motor, it was most natural to take the output of the motor as fixed.

Mr. Shelford Bidwell read a paper on "**The Electrical Properties of Selenium.**" The author has continued his investigations on this subject, and has come to the following conclusions: (1) The conductivity of crystalline Se appears to depend principally on the impurities which it contains in the form of metallic selenides; it may be that the selenides conduct electrolytically, and that the influence of light in increasing the conductivity is to be attributed to its property of facilitating the combination of Se with metals in contact with it (2) A Se cell having platinum electrodes, and made with Se to which about 3 per cent. of cuprous selenide has been added, is even, though unannealed, greatly superior both in conductivity and sensitiveness to a similar cell made with ordinary Se and annealed for several hours. (3) Red Se in contact with copper or brass is quickly darkened by the action of light, owing, it is suggested, to the formation of a selenide. (4) Crystalline Se is porous, and absorbs moisture from the air, and it is this moisture that causes the polarisation of Se after the passage of a current. (5) The presence of moisture is not essential to sensitiveness, but appears to be in a slight degree favourable to it. (6) If cuprous selenide is made the cathode in an electrolytic cell and a strip of platinum the anode in water, red Se mixed with detached particles of the selenide is deposited in the water. (7) The photo-electric currents sometimes set up when light falls upon Se are dependent upon the presence of moisture, and are no doubt of voltaic origin. (8) Perfectly dry Se is below platinum in the thermo-electric series.

Prof Minchin (communicated) suggested that the selenium "cell" should be called a selenium "resistance." A grid having one terminal made of aluminium and the other of copper might form a true cell, and might generate an E.M.F. when light fell on it. He (Prof. Minchin) would like to know if the author had tried any such cell in which light simply and solely generated an E.M.F. He could not agree that chemical action must necessarily follow the action of light in a cell For take the case of the oldest photo-electric cell—the thermopile—what chemical action can we show here for all the energy of the incident heat? Chemical action due to light may or may not occur, according to the nature of the cell.

Mr. Appleyard asked whether the author had submitted these selenium resistances to the action of electric oscillations. Prof. Minchin's impulsion cells were greatly influenced by electric oscillations. The great variation in the resistance with time of the author's cells pointed rather to an effect of contact between the selenium and the electrodes than to an elementary change in the structure or composition. He (Mr. Appleyard) had recently tried to crystallise a supersaturated solution of sodium sulphate by electric oscillation as well as by direct sparks and by currents of several amperes, but no crystals could be induced to form Change of contact, rather than change of structure appeared to him to be the most promising direction in which to look for an adequate theory of selenium resistance.

Prof. Ramsay said the quantity of Se liberated in the electrolytic experiment was much too great to be accounted for by oxygen dissolved in the water. The study of Se was very interesting, for that substance was on the borderland between those bodies in which the electric conduction was metallic and those in which it was known to be electrolytic.

The **Author**, in his reply, said he agreed that the name "selenium cell" was not an appropriate one. He had not tried the effect of electric oscillations.

The society then adjourned till the autumn.

COMPANIES' MEETINGS.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED

The half-yearly general meeting of this Company was held at the Cannon-street Hotel yesterday, Mr. S. W. Silver occupying the chair.

The **Chairman**, in moving the payment of an interim dividend of 2½ per cent, or 5s a share, free of income tax, reminded the shareholders that when they last met the prospects could not be said to be very encouraging, and allusion was then made to the caution necessary in opening new accounts in order to avoid losses. Coupled with this was the keen competition that prevailed on all sides, which rendered it necessary that extra care should be taken and great efforts made so that business might not be diminished. Speaking generally, he might say that the works, which were in first-rate order, both at Silvertown and at Persan-Beaumont, had been fairly well employed, with the exception of the submarine telegraph department, in which there were no contracts to report. As a matter of prudence and precaution, it was not, in the judgment of the directors, judicious to pay a higher interim dividend than 2½ per cent. on the present occasion. Subsequently, in reply to questions, he said that they did not propose to alter the usual form of the dividend circular, although the dividend was reduced. They had no further information to communicate with regard to the Pacific cable beyond what was contained in the telegram which we publish in another column, and the reserve fund remained as before.

The motion was ultimately unanimously adopted.

ELECTRIC AND GENERAL INVESTMENT COMPANY, LIMITED.

The ordinary meeting of this Company was held on the 2nd inst. at Winchester House, E C.

Mr. George Herring presided, and, in moving the adoption of the report, explained the principal items of the balance-sheet. He stated that the investments were entered at cost, but were absolutely worth the amount at which they appeared of £69,821. Their general charges increased with their profits. An interim dividend at the rate of 10 per cent. per annum for the half-year was paid last December, and out of the net amount of £5 330 now available for division they proposed to pay a dividend at the rate of 30 per cent. per annum for the past half-year on the ordinary shares, and a dividend of £20 per share for the year on the founders' shares. Taking it that their investments at cost price were of the value stated, then ordinary shares were at the present moment worth £1. 15s. each, plus the goodwill of the business, the capital of £1 a share being intact, the ordinary shareholders' reserve fund representing another 10s, and £5,000 being the ordinary shareholders' proportion of the item of £8,000 set aside as "provision for contingencies." They believed that if the reserve fund were cut up it would produce £140 for each of the founders' shares; the founders' capital of £5 a share was intact, and their portion of the provision for contingencies represented another £30 a share. Including the £35. 16s., also which was now to be paid, the founders' shares were at the present time worth £210, plus the goodwill of the business.

Mr. J. B. Braithwaite jun., seconded the motion, which was adopted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bristol.—The Committee of Visitors of the Bristol Lunatic Asylum, Fishponds, invite tenders by July 15 for supply and fixing the necessary wires, lamps, etc., for lighting the asylum by electricity.

Dortmund.—The Stadtgemeinde invites tenders by August 14 for the construction of a large electric central station. Conditions and plans may be obtained for one mark from Das Magistratsamt, Dortmund, Germany.

Hapton.—Tenders are required for the electric lighting of the village of Hapton from September 1 to April 30, 1896. Number of lights required will be about 50 Tenders to be sent to the chairman of the Hapton Parish Council before July 15.

Wellington.—The Shropshire Iron Company, Limited, Wellington, Salop, invite tenders for the erection of a complete electric lighting plant—two forges, three rolling-mills, one drawing and one galvanising mill, six warehouses, several shops. Plan of ground, etc., may be obtained from the company.

Blackburn.—The Corporation of Blackburn invite tenders for the wiring of the town hall. Copies of the specification may be obtained from the engineer, Mr. E. M Lacey, of 19, Old Queen-street, S.W., on payment of £1. 1s., which will be refunded on return of same accompanied by a *bonâ fide* tender. Plans may be seen at the office of the town clerk, or the engineer, from whom any further information can be obtained. Tenders must be sent in by July 13.

Wellington.—The Wellington (Salop) Urban District Council require tenders for lighting the urban area or lighting district with gas or electricity. The said district comprises about six miles of streets and roads, and is at present lighted by about 200 ordinary gas lamps and three of Sugg's patent treble lights. Further particulars may be obtained from the surveyor, Mr. G. J. Monson, C.E., 45, Walker-street, Wellington. Tenders, endorsed "Tender for Lighting," must be sent to the clerk, Urban Council, Wellington, Salop, by 12 noon on July 15.

Manchester.—The directors of the Manchester Ship Canal Company invite tenders for the work required for the permanent electric lighting of the Manchester and Salford Docks, including alternators and dynamos, arc and incandescent lamps, and cable wires, etc. The drawings may be inspected and copy of the specification obtained on payment of a deposit of £1, which will be refunded on receipt of a *bonâ fide* tender, at the engineer's office, 41, Spring-gardens, Manchester. Tenders, endorsed "Tender for Contract No. 51," must be delivered to Mr. A H. Whitmore, secretary, 41, Spring-gardens, Manchester, by 10 a.m. on July 10.

London, W.—The Hammersmith Vestry invite tenders for complete schemes for public and private lighting, and for the supply of motor power in that portion of the parish of Hammersmith described in the provisional order as the compulsory area. Memoranda of instructions, with a map of the district, may be obtained from Mr. H. Mair, surveyor to the Vestry, on or after July 10, 1895, between the hours of nine and five, Saturdays nine and one, on payment of a deposit of £10, which will be returned to persons sending in a *bonâ fide* tender. Tenders are to be delivered at the meeting of the Vestry, at the Vestry Hall, at 6.30 p.m. on September 4.

Dewsbury.—Tenders are invited for the wiring of their premises, for the Committee of the Dewsbury Pioneers' Industrial Co-operative Society, Limited. Copies of the specification may be obtained from the borough electrical engineer, Mr. J. B. Mitchell, Electricity Offices, Bradford-road, on payment of 10s. 6d., which will be

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refunded on return of same, accompanied by a *bonâ fide* tender. Plans may be seen at the office of the borough electrical engineer, Bradford-road, from whom any further information can be obtained. Sealed tenders, endorsed "Electric Lighting," must be sent to Mr. J. B. Mitchell, borough electrical engineer, Electricity Offices, Bradford-road, by July 8.

London, W.C.—The Metropolitan Asylums Board invite tenders for the supply and running of mains in the grounds and for the wiring of buildings now in course of erection at the North-Western Fever Hospital, Haverstock Hill. Conditions of contract and specification, prepared by Prof. Ayrton, may be purchased, price 10s., at the offices of the Board, Norfolk House, Norfolk-street, Strand, W.C. Deposited plans can be seen at the hospital any weekday between 11 a.m. and 4 p.m. on production of the specification. Sealed tenders prepared in accordance with the printed instructions, are to be delivered at the offices of the Board by 11 a.m. on July 18.

Rangoon.—The Rangoon Municipal Committee invite tenders for the lighting of Rangoon by electricity. Tenders should be accompanied by detailed plans, specifications, and estimates, and must state the terms on which the installation proposed will be undertaken. All information regarding the existing system of lighting and the cost, etc, with the plan of the town, can be obtained on application to Messrs. Ogilvie, Gillanders, and Co, Sun-court, 67, Cornhill, London, E.C., accompanied by a remittance of £1. 1s. Tenders, in sealed covers, and endorsed "Tender for Electric Lighting. Rangoon," to be sent to the president of the Rangoon Municipal Committee by November 4.

Portsmouth.—Tenders are invited by the Corporation for the supply and erection of conduits and indiarubber-covered electric mains, and for the supply and erection of compound-covered high-tension electric mains. Copies of the specification may be obtained from the town clerk at the Town Hall, Portsmouth, on and after July 1, on payment of £2. 2s. for each specification, which will be refunded on the return of the same, accompanied by a *bonâ fide* tender. Further information can be obtained from the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, London. Sealed tenders must be sent to Mr. Alexander Hellard, town clerk, at the Town Hall, Portsmouth, endorsed "Indiarubber-Covered Electric Mains and 'Compound'-Covered Electric Mains," as the case may be, not later than 6 p.m. on July 10.

Brighton.—The Brighton Town Council invite tenders for the supply and erection at their electricity works, North-road, of evaporative brass-tube surface condensers, electrically-driven air-pumps, exhaust and condenser piping; also for the supply and erection at the electricity works, North-road, of steam and feed piping, cast-iron storage tanks, feed-water filters, electrically-driven feed pumps, circulation economiser, coal-elevator, and sundries. Specifications can be obtained on application at the town clerk's office, Town Hall, Brighton, on payment of one guinea, which will be refunded on return of the specification, accompanied by a *bonâ fide* tender. Sealed tenders, addressed to Mr. Francis J. Tillstone, town clerk, endorsed "Tender for Condensers, etc.," or "Tender for Steam Piping, etc.," must be sent to the town clerk's office, Town Hall, Brighton, by 10 a.m. on July 15.

RESULTS OF TENDERS.

York.—Tenders for the supply of electric lighting plant and fittings for the Corporation have been received as follows:

Electric Construction Company, Wolverhampton	£10,865
Siemens Bros. and Co.	10,345
C. A. Parsons and Co.	10,266
Brush Electrical Engineering Company	8,360

Newcastle-on-Tyne.—The following tenders have been received for the electric light installation in the Presbyterian Church of England, Westmoreland-road:

Bland Bros.	£168	10	0
E. Scott and Mountain	118	0	0
Rowland, Barnett, and Co.	110	16	7
F. Reid, Ferrens, and Co.	95	0	0
Wynn and Barnard	82	10	0
R. J. Charlton and Co. (accepted)	80	0	0
S. Bury	63	0	0

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,552.

Electric and General Investment Company, Limited.—The warrants for the dividends, etc., have been posted.

Direct Spanish Telegraph Company.—For the month of June the receipts were £1,884, as against £1,617 for the same period of 1894.

West India and Panama Telegraph Company.—The receipts for the two weeks ended June 30 were £557 less than for the corresponding period of 1894.

City of London Electric Lighting Company, Limited.—The warrants for interest due on July 1 on the Company's 5 per cent. debenture stock have been posted.

Charing Cross and Strand Electricity Supply Corporation, Limited.—Payment was made of the half-yearly interest on the 5 per cent. mortgage debentures due on July 1.

House-Lighting.—Messrs. Drake and Gorham, of 66, Victoria-street, London, S.W., have obtained the contract for the electric lighting of Broome Hall, for Mr. A. H. Browne, M.P.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 30th ult. amounted to £1,193, as compared with £894 in the corresponding week of last year, being an increase of £299.

Dewsbury.—On the recommendation of the Building Committee, the Guardians have decided to have certain additional works done which are necessary to satisfactorily complete the electric lighting of the workhouse.

Chelsea Electricity Supply Company, Limited.—The directors have declared an interim dividend on the 6 per cent preference shares of the Company at the rate of 6 per cent. per annum for the half-year ended June 30, 1895, payable on July 18, 1895.

Metropolitan Asylums Board.—The Local Government Board has written to this authority authorising the laying and fixing of the mains and wires for the purpose of lighting the North-Western Hospital by electricity, at a cost of not exceeding £2,000.

Luton.—The town clerk has received a communication from the parliamentary agents of the Corporation anent the electric lighting question, stating that the confirming Bill was read on June 20 a second time in the House of Lords, and next day passed through committee.

Electrical Company, Limited.—At the general meeting of this Company, held on June 25, a resolution was passed by the Board appointing Mr. F. T. Eggers managing director. It was also decided that an important increase of capital should take place at the fall of the year.

Kingstown (Ireland).—The Town Commissioners have adopted a resolution to the effect that the town surveyor be directed to call the attention of the contractor for the electric tramways to the great inconvenience caused by the depositing of clay and other materials on the footpath

Personal.—Mr. Reginald J. Wallis-Jones, A.M.I.C E., M I.E.E., has been appointed engineer and manager of the Electric Welding Company, Limited, of 21, Hindon-street, London, S.W. Mr. Sydney W. Baynes, M.I.E.E, has been appointed electrical engineer to the St. Pancras Vestry.

United River Plate Telephone.—The accounts for the year ended March 31 show a balance, including £6,417 brought forward, of £16,319, from which the directors recommend, after transferring £3,000 to the depreciation and renewal fund, a distribution of 3 per cent., carrying forward £4,619.

City and South London Railway.—The returns for the week ended June 30 were £780, compared with £1,020 for the corresponding period of 1894, being a decrease of £240. The total receipts for the half-year are £23,873, against £23,638 in the corresponding period of 1894, an increase of £235.

Burnley.—Mr. Bird Clerke, an inspector of the Local Government Board, has conducted an enquiry into an application by the Corporation to borrow £70,500 for various schemes approved by the Council This sum included £3,000 for extending the electric lighting plant, £2,500 for new mains, and £1,000 for Town Hall fittings.

Capital and Counties Electricity Supply Company, Limited.—This Company has been registered, with a capital of £5,000 in £5 shares, for the purpose of carrying on business as electrical engineers and electricians, and to supply electricity for the purposes of light, heat, or power. Office: Palace-chambers, Bridge street, Westminster.

Commission of Sewers.—The Court have decided to carry out experiments in electrically lighting the minor streets of the City at a cost (for the experiments) of £386, and the Streets Committee has been requested, at the suggestion of the Incandescent Gas-light Company, to consider the desirability of experimenting also with incandescent gas lamps.

Newmarket Electric Light Company, Limited.—This Company has been registered, with a capital of £30,000 in £10 shares, with the object of carrying on the business of electrical engineers, electricians, engineers, contractors, suppliers of electricity, manufacturers of electrical appliances, chemical engineers, etc. Office: High-street, Newmarket St. Mary, Suffolk.

Mold.—Considerable satisfaction, a correspondent says, has been given by the decision to include Mold in the Buckley and Chester telephonic free area. The matter has been brought about by the influence of the representatives of Messrs. Thomas Parry and Co. The telephone will be a great boon to the locality, and has been actively taken up by traders, who have felt the loss of its advantages for some time past.

Town and Village Electric Light Company, Limited.—This Company has been registered, with a capital of £100,000, in 19,800 ordinary shares of £5 each and 1,000 founders' shares of £1 each, to acquire as a going concern and carry on the business of supplying electric light, heat, and power, as now and hitherto carried on by the Western Counties Electric Light and Power Syndicate, Limited, at Kingswood, Gloucester, and Keynsham, Somerset.

Wednesbury.—In bringing the report of the Highway, Market, and Stables Committee before the Town Council, a member stated that the Board of Trade had assented to the use of steam upon the Wednesbury and West Bromwich tramways for a further period of three months from the 15th inst. He said it was hoped that by the end of that time arrangements would be made to introduce what the committees of the district desired to see—the electric system on this part of the company's lines.

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Geo. Piggott and Co.—Messrs. Geo. Piggott and Co., of 110, Cannon-street, London, E.C., have been appointed from July 1, 1895, sole agents for London to Messrs. C. E. Collins and Co, of 55A, Dale-end, Birmingham, makers of high-class electric fittings of all descriptions. They were also recently appointed agents to Mr. F. M. Newton, of Taunton, Somerset, maker of the well-known "Taunton" dynamos and motors.

Fulham.—The Vestry has resumed the debate on the following motion, moved by Mr. Sayer, seconded by Mr. Cranfield: "That Messrs. Kincaid, Waller, and Manville be asked to give the necessary and preliminary advice as to the proposed introduction of electric light into Fulham, with or without a dust destructor, at a fee of £50." Mr. Thelwall had a long amendment referring to the Electric Lighting Committee various points upon which to report as to the effect upon the rates, etc. In the end it was decided to expend the £50, and to refer Mr. Thelwall's amendment to the committee.

Stretford.—A letter was read at the last ordinary meeting of the District Council stating that the Manchester Suburban Electric Supply Company intended to apply in the next session of Parliament for an order enabling the company to supply the district of Stretford with electric light, and asking the Council to facilitate the granting of the order. Mr. J. Wainwright said the question of the company being allowed to come into their district was a very important one, and ought to be well considered. He moved that the communication be referred to the Highways Committee. The motion was agreed to.

Nottingham.—Messrs. Calvert and Co., of 24, Exchange-buildings, Manchester, have secured the contract for the lighting of Colwick Hall and grounds, Nottingham. The installation, which will consist of a boiler, condensing engine, and 24 2,000 c.p. arc lamps, is expected to be ready by August 1. Although a comparatively new firm in this country, Messrs. Calvert and Co. may be recognised in connection with the lighting of the Eccles sewage farm, the outside lighting of the Southport Town Hall for the opening ceremony of the central station there, and the lighting of Mr. Otto Monsted's factory at Southall.

Copper.—Unusually large supplies of copper during June have increased the stocks in England and France and afloat to 58,182 tons, as against 54,211 tons at the end of May. The principal addition was not from North America, Spain, Chili, or Australia, but is tabulated by Messrs. Henry R. Merton and Co. under the head of "other countries," whose quota amounted to 6,874 tons, compared with 703 tons in the previous month. While, however, the total supplies reached 17,422—figures that have only been equalled twice in the last three years— the deliveries also showed considerable improvement, and came to 13,451 tons.

Douglas (I.o.M.).—The want of a tramway to Upper Douglas has, a correspondent says, long been felt, and through the generous offer of the electric tramway company, in consideration of an extension of lease, the project ere long seems destined to become an accomplished fact. In consequence of the want of communication visitors have stopped in the lower part of the town, and consequently in the upper part the value of property has considerably depreciated, and rents have gone down. A petition is to be presented to the Tynwald Court, which has been numerously signed, for leave to introduce a Bill embodying the necessary legislative powers.

Guildford.—A letter has been received by the Urban Sanitary Authority from the Board of Trade with respect to the application by the Guildford Electric Light Company for an extension of time in which to comply with the requirements of Section 7 of the Guildford electric lighting provisional order, and stating that an extension of time until December 17 next had been granted. The Assessment Committee of the Woking Urban District Council applied for the Guardians' consent to the appointment of a valuer to value the buildings and mains of the electric lighting company, and the buildings and mains of the water and gas company, in Woking.

Appointment Vacant.—The Bradford Corporation are prepared to receive applications for the appointment of an engineer to take charge of their electricity works. Applicants must have had experience in similar situations, and must be capable of superintending additions to and extensions of works. Salary to commence at £300 per annum. Print of duties may be obtained on application to the town clerk. Canvassing members of the Council will be a disqualification. Applications, endorsed "Electrical Engineer,' stating age and experience, and accompanied by testimonials, to be sent to Mr. W. T. McGowen, town clerk, Town Hall, Bradford, by the 17th inst.

Southampton.—The special sub-committee has met for the purpose of conferring with Mr. E. Manville, of Westminster, the electrical engineer engaged to report, on behalf of the Corporation, upon the value of the undertaking and works of the Southampton Electric Light and Power Company, Limited. Mr. Manville attended, and conferred with the committee at length upon the subject, and detailed instructions were given to that gentleman for the purpose of enabling him to prepare his report. Mr. Manville, with the deputy-chairman, subsequently made an inspection of the company's works, and promised to forward his written report as early as possible.

India Rubber and Gutta Percha Company.—The reduction in the interim dividend of this Company from 5 to 2½ per cent., which caused such a heavy fall in the shares last week, is not, the *Financial News* believes, due to any falling off in the Company's general business, but to a special reason. Tenders were invited some time ago for the new Pacific cable, and although nothing has yet been finally decided, the tender of the India Rubber Company was the lowest, and has every prospect of being accepted. It is probably in order to retain as much cash in hand as possible, in case they get the contract for laying the cable, that the directors have reduced the usual interim distribution.

Tunbridge Wells—Owing to some delay in the completion of the machinery, the public lighting will probably not be commenced for several weeks, but in the meanwhile a good many business establishments in the town are being wired in readiness for the current. A curious difficulty has arisen in connection with the installation of the light. A licensed victualler in the town had accepted a contract for the wiring of his house, and the work was commenced, but was stopped by the landlord, a well-known local brewer, who owns a number of licensed houses in which he refuses to allow the light to be installed. One of the reasons given is, we believe, that it would increase the inventory.

Aberystwyth.—The report of Mr. Preece, the engineer appointed by the Town Council to test the electric light in the town, has been received. Mr. Preece expressed himself as satisfied with the result of his inspection, and he recommended that the Council should procure an instrument for recording the power of the light. The report has been discussed at length by the Public Lights Committee, and it was decided ultimately, to recommend the Council to accept it. It was also agreed to instruct the surveyor to obtain prices of the instrument mentioned. In regard to Mr. Aslett's application for a lamp to be placed near the railway station, the town clerk was instructed to write asking Mr. Aslett whether it was the intention of the company to introduce the electric light at the station.

Edinburgh.—At a meeting of the Electric Light Sub-Committee of the Town Council, further consideration was given to the scheme authorised by the Town Council for the extension of the high-tension system to the south side of the city, and instructions were given to the officers to expedite the works, so as to ensure that by the beginning of winter the installation might be completed, parties thus having an opportunity during the summer months of wiring their houses. The same committee considered the subject of the salary of their resident engineer, in view of the large amount of duties undertaken by Mr. Monkhouse, and which were not included in his appointment, especially the road work in connection with the installation. The sub-committee, having regard to the large salaries paid to similar officers in other cities, resolved unanimously to recommend an increase of £100 to the present salary of £300.

Electric Welding.—On Thursday, June 27, the Electric Welding Company, Limited, of 21, Hindon-street, Pimlico, S.W., who own the patents for Great Britain of the Thomson process, exhibited at the conversazione held at the University College, Gower-street, W.C, an automatic wire-welding plant, which, when running, created a great amount of interest. This plant is, we are informed, the same type as that used by some of the largest cable and wire manufacturers in this country. The use of wire-welding plants in America is, it is known, very general, and we understand that the company is already making considerable headway with these machines in England. The Electric Welding Company also showed at the gathering mentioned a large variety of samples welded by their system, including cab and carriage tires, T and angle irons, tubes (butt welds), tool-steel shafts to mild-steel high carbon steel wires, copper wires, etc.

Belfast.—The Electric Lighting Committee of the Corporation have reported that they have accepted the tender of Messrs. S. Z. de Ferranti and Co. for the supply of meters, and that of Messrs. Poole and White for the supply of grip-boxes. They purpose advertising for tenders for the supply of appliances and stores, and for the construction of main extensions which may be required during the ensuing 12 months. They have received an additional grant of £5,000 from the Gas Committee. Alderman Pirrie, in moving the adoption of the report, said it would be gratifying to the Council to know that the extensions referred to in the report were necessary. They had at present 6,500 lamps at work, and the only thing they were not quite satisfied with was the fact that the manufacturers within the district had not made use of the power at their disposal, which would work their machinery cheaper than it was being worked at present. Alderman Lawther seconded the motion, which was passed.

Cheltenham.—The borough surveyor has reported to the Town Council that the electric lighting works are now completed so far as estimated for and in full working order, and the total cost has been £16,880. 14s. 1d., being £880. 14s. 1d. in excess of the original estimate and amount borrowed. The Council has resolved that the engineer estimate for lighting with arc lamps the Promenade to the Gordon Lamp, Clarence-street to the Great Western Railway Station, Ambrose-street, and from thence the High-street to the Royal Hotel, Pittville-street, Winchcombe-street, and Albion-street, to where the main is already laid. The overseers having assessed the electric light works at £400 net, it has been resolved that the town clerk be instructed to appeal to the Assessment Committee against the assessment. A resolution has been adopted in favour of the transference of the duty of dealing with street-lighting from the Streets Committee to the Electric Lighting Committee, henceforward to be called the Lighting Committee.

Lundy.—About 100 workmen are engaged in the erection of two new lighthouses on Lundy Island. As the work will take over two years to complete, two very comfortable barracks have been provided for the men. It often happens that while the present lighthouse is enshrouded in mist less elevated parts of the island are perfectly clear, so neither of the new lights will

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be more than 200ft. above sea-level, instead of 540ft., as in the case of the old beacon. Such will be the position of the new lights that one or other will be seen from whatever side of the island is approached. For one of the lighthouses the position will be Lametory, on the south-east point of the island, just inside Rat Island, and directly opposite Hartland Point. Here a white light will be fixed, with a fog signal similar to that at the Bishops (Scilly), guncotton detonators being exploded at a distance from the lighthouse by means of electricity. Space for the second lighthouse is being prepared at the north east point, a little west of the Constable Rock The lighthouses, which will be about 3½ miles apart, will be connected by telephone.

Bray (Ireland).—Sir Henry Cochrane said, at the last meeting of the Town Commissioners, that the Bray Improvement Bill had finally passed through Parliament, and it now only awaited the Royal assent to enable them to proceed with the various improvements it authorised. On the morning upon which the Bill came on for hearing they were advised that the Chairman of the House of Lords Committee had intimated to the Chairman of the Special Committee that the authorities of the House had decided that electrical powers be sought by provisional order, and not by parliamentary order, but that the powers to purchase the works and confirm the agreement entered into, and all the other powers sought, would be authorised by the passing of the Bill. Their Council at once accepted the position, which was the only course left open to them. The only other matter remaining was the opposition of the Dublin, Wicklow, and Wexford Railway Company. Now that the Bill had passed, he trusted that no time would be lost in giving effect to its provisions. It was to be regretted that the railway company should have thought it necessary to oppose this Bill in the Lords seeing that it had passed the Commons, and he could not help thinking they were badly advised.

Monmouth.—A local paper publishes an harangue from a correspondent anent the Monmouth electric lighting scheme, of which the following is the concluding portion: "The people have not been consulted. In a public movement of interest to every man, woman, and child in the town, and especially to every ratepayer, who will have to pay yearly his share of the heavy debt that will be incurred in starting and carrying on the electric lighting scheme, it appears to me that before any final step is taken in the matter, the inhabitants should be consulted, and their opinions taken and made known. If slips of paper, written for or against electric light, were delivered at every house, and given to every ratepayer, and everyone were asked to put his mark either for or against, as he wished, those papers would show an immense majority against the electric light. Or if a candidate for a seat at the Town Council went in on the ticket against the electric light, he would enter like a vessel does in a good tide into port. As one who wishes the real improvement, the solid good, and the permanent benefit, as far as they can be secured, without oppressively burdening the poor ratepayers of the town, I venture respectfully to ask the Town Council not to proceed any further with the lighting part of their scheme, before receiving the unmistakable sanction of the majority of the ratepayers to do so."

New London Mains.—The London County Council on Tuesday passed the following notifications of intention to lay mains—from the Westminster Electric Supply Corporation, to lay mains in Davies street, Berkeley-square (north and east sides), Hay-hill, Dover-street, Stafford-street, and Albemarle street, in Davies-street, in and across Robert-street, and in Duke-street, Grosvenor-square (north and west sides), in Victoria-street, thence into Orchard-street, in and across Millbank-street, across Broad-sanctuary into Dean's-yard; from the Metropolitan Electric Supply Company, to lay mains in St. Edmund's terrace, Well's-road, Albert-road, Titchfield-road, Avenue road, Townshend-road, Henry-street, Frederick-street, John-street, Charles street, Townshend-cottages, St. John's Wood-terrace, road, and park, Waranzow-road, Henstridge villas and place, Acacia-road, Ordnance-road, Edward-street, Upper York-place, Eaton-terrace, Queen's road, Outer Circle Regent's Park, Macclesfield bridge, Barrow-hill-road, Chapel-street, New-street, Wilton-place, Park-road, Upper William street, High-street, Marylebone, Cochrane-terrace, Douro-cottages, Wellington-road, Finchley-road, Circus-road, Lennard-place, Elm-tree road, Cavendish-road, Cavendish-road West, Oak-tree-road, Lodge road and place, North-bank, South-bank, Queen's-terrace, Grove End road, Waverley-place, Loudoun-road, Boundary-road, Marlborough-hill, road, and place, Langford-place, Abbey-road, Blenheim road and terrace, Carlton-hill, Clifton-hill, Greville place and road, and Mortimer-road (having regard to the large extent of these works, the Council was of opinion that should any of them not have been commenced within six months of the date of approval a fresh notice should be given in respect of those deferred); from the House-to House Electric Light Supply Company, to lay mains in High-street, Kensington; and from the London Electric Supply Corporation, to lay mains in Bermondsey-street, Market-street, Manning-street, Weston-street, Guy-street, Nelson-street, and Richardson-street.

London.—At the last meeting of the Court of Common Council at the Guildhall, Mr. Lee presented a report from the City Lands Committee asking for authority to appoint Mr. A. A. Voysey as consulting electrical engineer to the Corporation at an honorarium of £50 per annum, subject to annual election by the committee. Mr. Ellis protested against the appointment of another officer, and moved as an amendment that the question should be referred back to the committee for reconsideration. This amendment having been seconded, Mr. Shaw asked if it was possible for the Court to know the relative cost of gas and electricity at the Guildhall. Mr. Lee said the electrical current in 1893 cost £387, and gas £1,312, or a total of £1,700; in 1894 the electric light cost £513, and the gas £882. Mr. Lile reminded the Court that there was a great principle involved in the proposition. For some time past the Corporation had been economising in the amounts spent in charitable directions and the allowances that were made to the committees, and yet it was now proposed to spend £50 a year in appointing a new officer who had up to the present done nothing. Mr. Burnett remarked that the city surveyor had no one in his office who had a knowledge of electrical engineering Mr. Hollington said he had always understood that Mr. W. H. Preece was the consulting electrician to the Corporation. If that was so, why, he asked, was an attempt being made to create another office? He objected to the Court employing an officer who was in the service of a neighbouring body—namely, the Commission of Sewers—for such a purpose, and suggested that if the Corporation needed the services of a consulting engineer it should seek the advice of a professional man and pay the fee or fees, which he did not anticipate would cost £50 a year. Mr. Judd having condemned the proposition, Mr. Lee said it was quite true that the Corporation had from time to time consulted Mr. Preece, but very often that gentleman could not be got at, and the committee thought it would be better if the Corporation had the continuous assistance of Mr. Voysey. The Court, on a show of hands, negatived the report.

Dublin.—The Lord Mayor said, at the last meeting of the Corporation, that it would be well to put the public in possession of the facts in connection with the opposition of the Corporation to the United Tramways Bill last week in the House of Commons. The Bill was introduced last year, and contained no reference to the local authorities of the places where the lines were to run. The Bill contained power for the company to use any form of electric traction that the company pleased—a provision that might cause great public inconvenience. A deputation from the tramways company then waited on the Corporation, said that they were going to adopt the overhead wire system, advised the Corporation to see that system in use in Walsall, Brussels, Hamburg, and other places, and expressed the opinion that when the systems there in use were examined by the Corporation all opposition would be withdrawn. A number of members of the Council went to these cities and reported against the use of the overhead wire system. He also went to those cities, and while confirmed in his belief that the local authority should not have its powers set aside, yet he was impressed with the system in use in Brussels and Hamburg, and came to the conclusion that, subject to proper restrictions, that system might be introduced into some of their streets. When the Bill went into committee in Parliament the Corporation relied merely on their powers as a local authority, and a similar course was adopted by the Pembroke and Rathmines Commissioners. Upon that point it was ruled by the committee that the sanction of these bodies should be obtained to any scheme of electric traction that happened to be proposed. Next day the tramway company announced that, sooner than submit to the local authority in Dublin, Pembroke, and Rathmines, they would abandon their Bill. He thought that that was an unwise thing practically to defy the local authorities. The Corporation had always treated the company with the greatest forbearance. He thought that the attitude now assumed would affect their relations with the company, for that body could not in the future reasonably look for the concessions that they had hitherto got.

Leeds.—The report of the Sub-Highways (Tramways) Committee of the Leeds Corporation, on the subject of tramway haulage, has been considered at a meeting of the Highways Committee. Councillor J. F. Carter, who is also a member of the sub-committee, has all along strongly opposed the adoption of any electrical system, and he again made his protest, though he advocated no alternative system. By another member a question was raised as to whether the recommendations embodied in the sub-committee's report had been passed unanimously. To this, Alderman Firth replied that at the first meeting, when it was agreed to recommend the adoption of electric haulage, every member present voted in favour of this, and that one Conservative member not only voted for electricity, but spoke in favour of it. At the last sub-committee meeting, however, this member (Mr. Denison) had voted against electricity. He (the chairman) challenged Mr. Denison with changing front on the question, and Mr. Denison's answer was that he had only changed his mind once At yesterday's meeting Mr. Mart and Mr. Ringrose expressed themselves strongly in favour of the adoption of the overhead electrical system for the whole city. The former laid particular stress on the fact that the overhead and conduit electrical systems had not hitherto been tried in conjunction He, therefore, thought the Corporation ought to move very cautiously in the matter. He said that if a clause were inserted in the report to the effect that only one short length of conduit would at the outset be tried, he should vote for the adoption of the sub-committee's recommendations. The Chairman informed Mr. Mart that although four lengths of conduit were named in the report, one only would be laid at the outset, and that if the experiment did not prove satisfactory the other lengths would not, of course, be proceeded with. Mr. Mart urged that a statement to that effect should be added to the report. It was not considered necessary to do this, however, and, on the motion of Alderman Ward, a resolution was passed recommending the Council to adopt the report as it stands. It was further decided to request the Mayor (Alderman Gilston) to convene a special meeting of the Council at any early date to consider the matter. In the meantime, copies of the report will be forwarded to every member of the Corporation. The three members of the committee who voted against

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Alderman's Ward's proposition were Councillor J. F. Carter, Councillor Denison, and Councillor Ringrose. The latter is not opposed to electrical haulage, but objects to the conduit system being recommended for the centre of the city.

Eccles.—At a meeting of the Town Council, held on July 1, Mr. Alderman Kendall, in moving the adoption of the minutes of the Tramways and Electric Lighting Committee, said that the Corporation had obtained a 12 months' extension of the time during which they were to construct the works. The consulting electrical engineer to the borough (Mr. Clirehugh) submitted a report to the committee showing "that for the public and private lighting of the borough combined the capital outlay would be involved of £18,971, but that no charge upon the rates would be necessitated, as while the annual running expenses, including maintenance and machinery, interest on capital and payment to sinking fund, so as to pay off the loan in less than 30 years, would be £2,066, the receipts would be £2,590, or a surplus of £524. It also showed that if the Council were to undertake the lighting of the street lamps only, although the figures for capital outlay and annual cost would come up to not far short of the above figures, there would be a margin of saving as compared with the annual sum at present paid for lighting, etc., of the street lamps, the figures being: capital outlay £15,000 in round figures, and annual cost £1,560, as against an annual sum for gas lighting and other matters which would cease to be expended by the Watch Committee and the Corporation of £1,690, leaving a margin in favour of electric lighting of £130, out of which, however, there would be a sum payable for rates and taxes, which had not been calculated, as it was impossible to say upon what assessment they would be based." Mr. F. Oldfield seconded the motion. Mr. Alderman Mellor admitted that the electrical engineer had done his best to lay before the Council a scheme showing a profit, but his (Mr. Mellor's) opinion was that there would be an increase of a 1d. or 2d. in the pound in the rates. After a lengthy discussion the minutes were confirmed, 10 voting for the resolution and eight for an amendment moved by Mr Alderman Spary that before application was made to the Local Government Board for the necessary borrowing powers, plans, specifications, and tenders should be laid before the Council for consideration. The report of the engineer was afterwards adopted, and the committee were empowered to incur the necessary expenditure required to carry out the provisional order.

Peterborough.—The Town Council in committee have formally adopted the scheme prepared by Mr. Gill, the Corporation engineer, for lighting the central portion of the city with electricity. The scheme is to cost £15,000 Mr. Gill has also submitted a plan for adapting the premises recently acquired in Queen-street for the purpose of an electric light station. The boiler house will be placed on part of the land adjoining, and the plan also provides a chimney shaft, 100ft. high, which will be placed near Messrs. Barford and Perkins's works. The committee has expressed every confidence in Mr. Gill, and decided not to proceed to the appointment of a consulting engineer, as had been suggested. Mr. Gill was asked to push on with the details of the scheme as quickly as possible. Before the work can be commenced the scheme must receive the approval of the Board of Trade, and the Local Government Board will be asked to sanction a loan of money required to be spread over a number of years. The Lighting Committee reported on Tuesday that Mr. Pearson had proposed, and Alderman Hunting seconded, that Mr. J. C. Gill be appointed electrical engineer for the borough, which was carried without dissent, and further, that he paid £100 a year, commencing from June 25. Mr. Beaver said £100 might be a fair remuneration, but taking into consideration the other offices which Mr. Gill held he thought it was too much. In considering the matter of the engineer's salary, which had gone up by leaps and bounds, it had been the understanding that the whole of Mr. Gill's time should be given to the work in which he was engaged. If he was to undertake this fresh department—and he hoped he would—the time which he gave to it must necessarily be taken from that of his other office. He moved, as an amendment, that the salary be fixed in connection with the duties of waterworks engineer, that sum not to exceed £350. At present they were not sure whether the works were going to be successful, and he would rather wait a while and see them fairly started before fixing anything definite. Mr. Cliffe said if Mr. Beaver would alter his motion so as so refer the matter back to committee, he would second it. The Deputy-Mayor asked whether the £100 recommended was in addition to the increase in Mr. Gill's salary as waterworks engineer, recommended some time ago. Mr. Pearson: It was taken into consideration at the time. At the time Mr. Gill asked for this increase it was foreshadowed that he would want more when this work came on. I am rather sorry Mr. Beaver has reopened the matter. Mr. Beaver said he was quite willing that the matter should be referred back to the committee. Mr. Simpson said the question had been debated quite sufficiently in committee already. Mr. J. Hunting, having ascertained that there was no intention of appointing another officer, said the action taken by Mr. Beaver practically amounted to appointing a man to an office, and paying him nothing for the work When Mr. Gill received his last increase he was distinctly asked if he intended it to cover any new appointment, and like an honest man he said "No." It was never intended that it should. They ought to take into consideration the fact that Mr. Gill had practically thrown up a situation of £500 a year because the Council did not wish him to leave, and surely this ought to be some reason why they should give him what he was fairly entitled to. Mr. Miller said there was a difference of opinion in committee on the subject. Mr. Clifton considered Mr. Beaver was acting most unfairly towards Mr. Gill, and he challenged him to find an electric lighting engineer in England who was paid so small a salary as Mr. Gill was willing to accept. It was certainly very poor reward for the great energy Mr. Gill had brought to bear in connection with the preliminary work. Mr. Beaver, in reply, said he had no wish to be unfair to Mr. Gill, and neither did he wish him to do any work for nothing. It was absurd to think he did. Mr. Gill's salary at the present time was £275, and his proposal was that it should be raised to £350. The minute was confirmed by seven votes to three.

Madras Tramways.—There are two aspects of the Madras tramways question—one that presents itself to the plain investor, and the other which its electrical engineer, Mr. Charles H. Gadsby, affords—picturesque, scientific, and making sure of eventual dividends. In the latter, however, the enterprise is admitted to have been a ludicrously slow and uphill affair, and it turns out just as we expected it to be—not the fault of the electric part of the business. Instead of making the decision between steam traction and the resort to electricity, the promoters and authorities are said to have refrained from consulting an expert as to which of the electric systems was best suited to the conditions of Madras. In fact, there must have been a toss, and electricity won it. It may be that the shareholders of the tramways did the right thing in thus stumbling upon the adoption of electric traction without the guidance of electricians, but the inquisition we are upon is, whether intending and future shareholders will be as easily led; and we were looking at the matter more from their standpoint, aware that no class are so timorous as capitalists. It is difficult to treat with Mr. Gadsby's criticisms on our reasons for preferring the Batavian principle of pressure steam haulage for the circumstances of Madras, till satisfied that we are all speaking about exactly the same thing, and that there is no lead off to side issues, such as double *versus* triple expansion, or what they do at home, where it is notorious the instinct is against novelty. Even electric railways had long been in use in America before they were introduced into England. However, it is quite intelligible why the Batavian system has never been advocated for a cold climate, and to state the grounds would be merely recounting those which recommend it for a place like Madras, which is piping hot every day and night in the year. The discussion is really narrowed down by Mr. Gadsby's letter to the very simple point, whether the flatness and extent of field combined with dear fuel—which we in the innocence of the investing public thought were the very last reasons for using electric traction at Madras—are not, on the contray, the strongest in its favour. As to flat roads, they are the best for every tramline wanted to pay, and may be placed out of account. The leakage of electricity carried underground or even near ground level is known to be very great. That of an overhead electric system no one is probably better qualified than Mr. Gadsby to tell us. As to whether even an overhead current of great strength can be insulated without vulcanite or indiarubber by unaided china cups one may be sceptical, but this is of comparative unimportance. What really weighs with investors is the ducks and drakes that one of the cyclones which visit Madras would make of overhead wires. It is difficult to imagine a single wire "over the track." In America there is that one main wire, it is true, but it is supported on cross wires the width of the road, strained between lines of posts on either side. Where lines join at certain corners of streets, there is a very complex arrangement of wires to allow of cars turning and passing each other. The wires over a wide area with tram routes in many different directions would, the higher the observer was stationed, the more closely resemble a cobweb in a rough kind of manner, and the action of the inevitable cyclone is easiest brought home by this figure of speech. Of course, it is not fatal to the success of the tramways—that would be ridiculous—but to shareholders what "interrupts traffic for a few days" may look excusably serious. There is well known to be an enormous wastage of the power of an electric current in transmission along lines of wire, which does not signify where there is water power to generate electricity, but is everything when a steam-engine has to be employed. To state what it is would be of little use, unless we had the figures to give for the loss at Batavia from radiation and condensation, in order to make the comparison. But that loss would be about its minimum at Madras, a much warmer place than Batavia and as warm as any on the earth's surface, it is tolerably certain. The electric loss, on the contrary, would be the same as, or, as the air is moister, probably greater than in England.—*Indian Engineering* of June 8.

Croydon.—We referred briefly last week to the fact that Major-General C. Phipps Carey, R E., an inspector of the Local Government Board, had attended at the Municipal Offices, Croydon, for the purpose of enquiring into an application by the Town Council for sanction to borrow £27,500 for purposes of electric lighting. The Town Clerk said he proposed to call one or two witnesses to show what the Council had done in the matter of electric lighting, to show that there was a demand for electric lighting, and then he would call Prof. Kennedy to explain the details of the scheme. He wished to say, however, with regard to the order of the Board of Trade of 1891—which order could be revoked at any time—that he had written to the Board and had received a letter stating that the Board would be prepared to defer the consideration of the question of revocation of the order for two years, provided steps be taken to give effect to the order without unnecessary delay. Alderman David Buck Miller, J.P., said he was vice-chairman of the General Purposes Committee and chairman of a sub-committee specially appointed by that committee in connection with the proposed introduction of the electric light into the borough. He had for some years past taken a very active interest in the question of introducing the

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electric light into Croydon. He shortly stated the proceedings of the Council in regard to the question, and said that a provisional order was obtained by the Council authorising the Corporation to carry out the electric lighting and that order was confirmed by an Act which received the Royal assent on July 4, 1891. On November 16, 1891, the Council adopted a recommendation of the General Purposes Committee that they should not then determine what steps should be taken to carry out the provisional order, but should wait and see how electric lighting in the hands of the Corporations of Bradford and Brighton might develop, and also see what decisions might be come to by several of the corporations which had then obtained electric lighting orders, but had not decided upon the mode of carrying them into effect. The Council were at that time and for a long period much divided in opinion as to whether it would be better to transfer the powers conferred by the provisional order to some company, or whether it would be better for the Corporation itself to take the responsibility of carrying out the work. On February 11, 1892, the committee reported an offer they had received from a firm of electrical engineers for the transfer of the electric lighting order, but the Council did not accept that offer. On July 25, 1892, the Council had in consideration a renewal of the offer on slightly different terms, but did not accept it. The committee then advertised inviting offers for the transfer of the powers of the Corporation. Offers were received and were reported by the committee to the Council on September 22, 1892. The Council on September 26, 1892, upon the recommendation of the committee, resolved that they would carry out the powers of the order themselves, either then or at a future date. On January 18, 1893, the committee brought up a recommendation that the Corporation should carry out the lighting of the compulsory area, and that an application should be made to the Local Government Board for sanction to a loan. That recommendation was referred back to the committee, as were also subsequent ones. The matter slept until October last year, when the committee recommended to the Council that an arrangement should be made with some contractors to carry out, on behalf of the Corporation, the powers of the order, but that the contractors should maintain and work the undertaking for a term of years, guaranteeing the Corporation the interest and sinking fund upon the capital expended. The recommendation came before the Council on October 29, 1894, and was adopted *nem. con.* Witness believed that the members of the Council who previously had opposed the introduction of the electric light fully concurred in the recommendations of the committee, which were adopted on October 29. He had made enquiries of the traders in the centre of the town, and found that a great majority of them were prepared to agree to take the light. In several of the new buildings recently erected in the High-street in consequence of the improvements there, private installations had been, or were being, put up; but he had reason to believe that as soon as electricity could be supplied from a central station these private installations would be thrown out of gear, and that the occupiers of property would gladly take the electric light. The Corporation were themselves erecting a new town hall, including courts and free library and reading-room, and would be large consumers there of electric light. Witness had very thoroughly gone into the details of the scheme, for which it was proposed to borrow £27,500, and considered that the scheme adequately provided a system which would serve as a nucleus for the general installation of the electric light throughout the borough. With regard to the site of the electric light installation, the proposal now submitted to the committee contemplated that the station should be erected upon land belonging to the Corporation, and adjoining their dust depôt at Brimstone Barn. This land was close to the railway, and a siding could be conveniently arranged. It was also near to a branch of the Wandle, from which water could be pumped for the purpose of the works, and into which the water could again be returned after use. It would, in his opinion, be preferable, if it could be so arranged, to use a portion of the ground purchased by the Corporation under the Allotments Act, and witness proposed to seek the authority of the Council to lay before the Local Government Board a proposal to appropriate a portion of the allotment ground, purchasing at the expense of the electric lighting undertaking a corresponding area of land close by, and, of course, liberally compensating the tenants of the allotments who might have to shift. The allotment ground would be preferable, because a larger area could be made available, and it was much nearer to the stream, and also would be more conveniently available for a siding from the railway. Communications had from time to time been had with the Board of Trade with regard to the delay that had taken place on the part of the Corporation in carrying out the powers of the provisional order, but witness believed the Board would not revoke the powers of the Corporation if the Local Government Board sanctioned the present scheme. Prof. A. B. W. Kennedy stated that he had had considerable experience in advising upon and carrying out electric lighting works all over the country, both in London and for the Corporations of Glasgow, Edinburgh, Oldham, Belfast, Aberdeen, Sunderland, etc. He had carefully considered the scheme proposed to be carried out in Croydon, and considered it adequate and suitable for the purpose. The system proposed was a high-tension alternating system, which would satisfy immediate requirements, and would permit of extension as required to the outlying districts of the borough without unreasonable expense. Witness put in a map of the borough showing the compulsory area, and also an estimate showing how he arrived at the proposed expenditure of £27,500. The position chosen for the central station, as described by Alderman Miller, appeared to be well chosen and thoroughly suitable. Witness found no other site in Croydon which was by any means so suitable for the purpose. It was close to the railway, from which a coal siding could be made, and was also sufficiently near the Wandle to allow of the steam-engines being worked with condensation. It was proposed to put down, in the first instance, three steel multitubular steam-boilers, each capable of evaporating 6,750lb. of water per hour from cold feed. There would be two feed pumps, each being capable of delivering 1,800 gallons per hour, and a fuel economiser. In the engine-room it was proposed to start three compound vertical condensing engines, each driving an alternating-current dynamo of about 120 kilowatts capacity direct, and either one or two alternators, with battery—for running at times of light load without the necessity of using steam—the necessary exciters for this plant, condenser and air-pump, and suitable switchboards and instruments complete. It was further proposed to erect the station of sufficient size to accommodate machinery to generate electricity for the supply of an extended area. With regard to mains, it was proposed to have in the first instance three or four high-pressure feeders to the centre of the town, each ending in transformer sub-stations, and having in all a carrying capacity of 120 amperes, which, at 2,000 volts would give 240 kilowatts. The network of distributing mains would be at low pressure, either two or three wires, as might be found most convenient. All consumers in the central area would be supplied from low-tension mains direct. Isolated consumers would be supplied from the high-tension mains by the use of separate transformers. The mains would be concentric throughout, and would be carried out so that the permission of the Board of Trade could be obtained to earth the outer conductor in the station. It was proposed to have five transformer sub-stations with suitable transformers and equipments. The apparatus provided for would be sufficient to supply current for 10,000 lamps connected, which witness, having considered the subject, thought a suitable number to start with. He was of opinion that the estimate of £27,500 was a fair and reasonable estimate, and believed that the work contemplated by the Corporation could be adequately carried out for that sum. The Inspector thought that the Local Government Board would require more detailed plans than he had before him. For instance, there were no detailed plans whatever of the building. Prof. Kennedy said he could prepare further plans and send them on to the Local Government Board. The Inspector asked whether the company would accept the plant provided? Prof. Kennedy said they had supplied their own specifications, and had agreed to all the details he had given the inspector. The Inspector asked if the estimate of £27,500 was absolutely necessary to supply the electric light to this area. Prof. Kennedy said it provided for a larger building than would be necessary for the supply of the larger area. The Inspector said he would like to know something about the company to whom the Corporation was going to transfer its power. The town clerk handed in the report of the General Purposes Committee of April 4, 1895, referring to the arrangements between the two bodies, etc. He added that the name of the company was the British Thomson-Houston Company, and in the case of any hitch in the negotiations the Corporation reserved to themselves the right of negotiating with another company. Such a contingency had not arisen, and as yet the agreement had not been sealed, but was waiting the result of the present enquiry. In answer to the inspector, Prof. Kennedy said that nothing would come out of the rates. At Brighton and Bradford they were making a profit, while at Aberdeen and Oldham during the first year of working they both paid the whole expenses of the installation, the whole of the interest, and, in the case of Aberdeen, the whole of the sinking fund. There was no opposition to the scheme.

York.—A special meeting of the City Council has been held to further consider the report of the Streets and Building Committee, acting as the Electric Lighting Committee for the city, presented to the Council on April 29 last, together with a report of inspections by the Electric Lighting Sub-Committee of works in other towns and estimate of cost of complete equipment, on the same basis, of each of the four schemes submitted by firms whose tenders are reserved for consideration. Mr. Alderman Agar moved the reception of the report of the inspections by the Electric Lighting Sub Committee of the various works. This was seconded by Mr. Walker. Mr. Alderman Wragge asked in the event of the Council refusing to adopt any system of electric lighting in the city, what would be the result if any company started a system within the prescribed area? What would be the rights of those outside the area requiring the light? Mr. Brown asked why they were only going to apply for borrowing powers for £15,000, when the Electric Construction Company's work required £16,465? Mr. Pearson asked, if the Corporation did not adopt a system of electric lighting and left it to a private company, whether that private company might be put on terms with regard to a purchase by the Corporation at a later date. Mr. Alderman Agar said that the figure of £15,000 was put down before they had the full estimate for building, which would come to more than was anticipated at the commencement of the scheme. It was thought that £15,000 would be about the mark. The Town Clerk, in reply to Mr. Alderman Wragge, said that the position at present was that the Corporation had obtained at the beginning a monopoly with regard to the supply of electricity for lighting purposes in the city. So long as their powers remained in force no other body and no person could supply electricity to bodies or persons other than themselves. That was to say, it was quite open for any person to lay down electric lighting plant for lighting for their own purposes,

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but directly they supplied it to any other persons they would be infringing the rights of the Corporation. Then, again, any private company without parliamentary authority breaking up the footpaths for the purpose of electric lighting would be treated as trespassers. If he was asked what would be the effect of the Corporation refusing to adopt any system, if the Board of Trade found that they had no *bonâ fide* intention of doing so, the Board of Trade would listen to applications from various companies for provisional orders and grant them. Since the Council last met he had received a further letter from the Board of Trade, which he submitted to the Electric Lighting Committee, in which they asked what the Council intended to do, and he replied informing them of that meeting. In reply to Mr. Pearson's question it was impossible to foretell what might happen. As a Corporation they might oppose any application for a provisional order. They could, then, in view of that opposition, come to terms with that company, and certain terms of purchase might be inserted in the provisional order. Mr. Alderman Agar, in moving the adoption of the report, said the particulars of the visit which the committee had made showed how arduous their labours had been. As regarded the tender which the committee recommended for acceptance—that of the Electric Construction Company—he left the advocacy of it to the seconder of the adoption of the report. Mr. Mann, in seconding, pointed out that the installation by the Electric Construction Company embodied what was called the "Oxford" system. The difficulties of the Council in making an installation were twofold—first to make it pay, and next, as far as possible, to get over satisfactorily the day load. They were aware that during the period from midnight to four or five o'clock, unless they wished the light to be intermittent, they must have the machinery going day or night, and one great objection to the alternating current was that it must be kept continually running. Mr. Alderman Wragge said the committee had been very much divided on this question. Their deliberations had extended six years, and their constitution had changed seven times. Three experts had given their opinion, the committee had visited 13 stations, and no less than 26 tenders had been received. It was remarkable that the committee recommended the highest tender, and in departing from the usual custom of recommending the lowest tender he thought sufficient reasons should have been advanced. In criticising the vote of the committee when they recommended the adoption of this particular tender, the speaker said the majority of five was made up of one old member of the committee, one partially new member, and three entirely new ones, whereas in the minority of four were included gentlemen who had gone through the whole question from the outset. Dealing with the adoption of the Electric Construction Company's installation at Oxford, he said that in a city with a population of 45,000 the system had cost £62,538, and was worked from one central and five sub-stations. By adopting the system recommended they would require a sub-station in whatever district they desired to supply the light, whereas under the alternating high-tension system there was no necessity to have sub-stations. He expected that in York they would require seven sub-stations. In connection with the Oxford system it cost 3½d. per unit to produce, and reckoning the interest and sinking fund at 7½d. they obtained a total of 11d. Assuming they sold the current at 6d. per unit, there was a loss of 5d., which would fall upon the rates. If the outlay at Oxford had been what he had stated, how could they expect the same company would at a quarter the expense supply the ratepayers of York in a much better way, and make the installation a gain rather than a loss? It was all very well to deal with a compulsory area, but it must be remembered that the locality marked out was the locality that would pay best, and if they allowed a company to step in and supply that area the latter would snap their fingers at the Corporation and lay down a low-tension plant, and then the Corporation would have to supply other parts of the city that would not pay so well. Compared with the Brush Electrical Engineering Company, he believed that if they accepted the tender recommended the cost of transformers would be three times as much, and of feed mains twice as much. The town clerk read the following amendment, which was accepted by Mr. Alderman Wragge: "That the tender of the Brush Electrical Engineering Company be accepted, provided an arrangement can be made with them for the making of the plant by the company for a term of years on the basis of their letter of January 31, 1895, but subject to the modifications of the terms thereof." Mr. Alderman Coning said that he had no objection to second that amendment so far as the adoption of the Brush Company's tender was concerned. Mr. Alderman Wragge had, he thought, made out a very good case indeed. Why he objected to the hasty adoption of terms was because he felt that the company were going to have a good chance in being allowed to supply that light in the very heart of the city where there must be the largest demand. It was just possible that they might make a profit for two years, but what would be their position when they took over the concern, which was the very crux of the matter? The moment they got it into their hands, that moment they would be compelled to supply to the area not before included. It might be on terms, but the ratepayers would have to be fairly treated. The limit of two years was not a wise limit—it should be more elastic. That was, they should be allowed to take over the concern within a certain period on terms now to be definitely and distinctly made. Mr. Atkinson urged that by accepting the conditions of the Brush Company the Corporation would be giving itself into the hands of that company. He argued in favour of the tender of the Electrical Construction Company as being the most practicable, and that it would work out the best and cheapest in the end. Mr. Pearson said he knew full well that if the Council did not supply the electric light itself it would let in a company—a thing which he should very much deprecate indeed—but on the other hand he felt that the Council could not possibly, or he as a member of it could not, consent to join in sanctioning a scheme which at the present moment would in all probability be an expense to the ratepayers. He would like to see a company come and establish a system and work it, and that there should be terms made with them giving the Corporation power to take over the system in five or ten years, or at such a time as the city would bear it or be assured that it would not be a burden upon it. He could not vote either for the adoption of the report or for the amendment. The amendment was then put, when four voted for the amendment, 10 against, and 12 neutral. The amendment was, therefore, lost Mr. Purnell dealt with the advantages of the high-tension over the low-tension system, and contended that the value of each must be measured (so far as they were concerned), firstly, by its comparative power to provide and maintain electricity for all purposes; secondly, by its economy in setting up a complete installation; thirdly, by annual cost of its working; fourthly, by its safety or danger to its users and the public; and, fifthly, by its facility to reach all parts of the city and serve with ease all the ratepayers; and it was in that light he wished the Council to view the tenders before them. High tension was the more modern of the two systems, embodied the latest improvements and ideas, and was practically almost universal in America and on the Continent of Europe. All systems embracing low tension were necessarily limited in their power to supply, and could not embrace an area with a five-wire cable of more than 2,000 yards. High tension, with a two-wire cable, would embrace any area they would ever require from a central station in York. Low tension required a much larger central station to contain its plant and accumulators or secondary batteries, and if they added fresh areas, sub-stations in costly districts. High tension could have its one central station anywhere where they could get cheap land for the purpose, and they only required one station. Having gone through the various tenders, he advocated the acceptance of the tender of Messrs. C A. Parsons and Co., which was a high-tension system, but differing somewhat in the means by which it obtained its results. The system was a well-tried one, having been in use at Newcastle for over six years, and to-day the same turbines and cables were in use, and were as good, true, and serviceable as the day they were first put down. He moved "That the tender of Messrs. Parsons and Co. be accepted, subject to arrangements being made to the satisfaction of this Council for the working of the plant by the company for a term of years" Mr. J. S. Gray agreed that Messrs. Parsons and Co.'s tender involved the lowest capital expenditure, and was at least as low as the others for maintenance. He suggested that some such terms as were indicated in the Brush Company's alternative offer should be asked from Messrs. Parsons. Mr. Alderman Agar thought it was only fair that Siemens's should be included. Each firm ought to have the opportunity of saying on what terms they would supply the Corporation for a specified period of years. After some further discussion the amendment was lost, six voting for it and 13 against, eight being neutral. Mr. Scott said he would like to move that they request Prof. Kennedy to draw up a specification on the lines of the report of the city surveyor. They would never get a satisfactory tender until they had made up their minds as to the system they were going to adopt. It was evident that the more they discussed the matter, either the high-tension alternating or the low-tension continuous current would be too costly in their initial stages. In further remarks he said that Prof Kennedy would require to make a special journey, and he then altered his amendment to read to the effect that the matter be referred back to the committee in order that Prof. Kennedy's opinion might be obtained on the question of high or low tension. Mr. Proctor seconded. Mr. Alderman Wragge said this meant the payment of a fee of 100 guineas to ask Mr. Kennedy to tell them what they had already decided. The amendment was lost by a large majority, only the mover and seconder voting for it. Mr. Scott would like the Corporation to get further information as to the two latest corporate installations, Chester and Burnley, and moved the referring of the matter back with that object. The Lord Mayor said he could not accept that. After some little conversation, Mr. Alderman Coning moved, "That the report be referred back to the committee for reconsideration, and with an instruction to ascertain the terms upon which each of the four firms whose tenders they have reported upon will undertake the supply of the plant necessary for the lighting of the city and the working of the same for a term of years." Mr. Alderman Wragge seconded. The amendment was carried by 17 to 4, three being neutral, and on becoming the substantive resolution was agreed to.

PROVISIONAL PATENTS, 1895.

JUNE 24.

12187. **Improvements in telephonic apparatus.** Henry Capel Lofft Holden, Royal Arsenal, Woolwich.

12229. **Improvements in electric resistances and in the manufacture thereof** Heinrich Julius Ferdinand Voigt and Jacob Adolf Haeffner, 6, Lord-street, Liverpool. (Complete specification.)

12244. **Improvements in electro deposition.** John Cameron Graham, 18, Southampton-buildings, Chancery-lane, London.

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12232. **Improvements in or appertaining to the manufacture of electric cables and of materials therefor.** James Basnett Atherton and George Hinde Nisbett, 6, Lord-street, Liverpool.

JUNE 25.

12283. **Improvements in devices for attaching electric conductors to their supports.** Alfred Julius Boult, 323, High Holborn, London. (Leopold Karl Kugler, Germany.)

12301. **Improvements in dynamos, motors, and alternators.** Llewelyn Birchall Atkinson, 1, Queen Victoria-street, London.

12311. **Improvements in contact or collector bars for the overhead conductors of electrical railways and tramways.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.)

12329. **Improvements in and relating to telegraphic systems and instruments therefor.** Adolf Merrel and Artur Duffek, 8, Quality-court, Chancery-lane, London. (Complete specification.)

JUNE 26.

12374. **Improved means for indicating and controlling the supply of electricity to portable and other electric lamps and apparatus.** Robert Hacking and George Brand, 78, Fleet-street, London.

12394. **A new or improved apparatus for indicating the time and number of telephonic communications.** Erich Kosanke, Carl Fuhr, and Bruno Krausse, 18, Buckingham-street, Strand, London.

12404. **Improvements in electricity meters.** George Hookham, 18, Southampton-buildings, Chancery-lane, London.

JUNE 27.

12412. **A combined heat radiator and electric lamp shade.** Arthur Lester Taylor, 36, Dale-street, Liverpool.

12414. **Improvements in apparatus for electrically lighting vehicles.** Job Thomas Niblett, 20, Devonshire road, Greenwich, London.

12417. **Improvements in the manufacture of positive plates for secondary electrical batteries.** Carl Hugo Weise, 70, Market-street, Manchester. (Complete specification.)

12420. **Improvements in the manufacture of plates for secondary electrical batteries.** Carl Hugo Weise, 70, Market-street, Manchester. (Complete specification.)

12438. **Ventilators for culverts, tubes, pipes, boxes, and chambers laid or fixed in roads and footpaths in connection with the distribution of electricity.** William Weaver, Kensington Town Hall, London.

12468. **Improvements relating to the current supply of electric railways by an auxiliary accumulator battery.** Adolph Müller, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12469. **Improvements relating to electric railway vehicles.** Adolph Müller 45 Southampton-buildings, Chancery-lane, London. (Complete specification.)

JUNE 28.

12477. **Improvements in and connected with the insulation of storage cells, batteries, etc.** Kenneth James Tarrant and Carrington Riddell Gordon Smythe, 12, Idol-lane, London.

12498. **An improved compound for electrical insulating purposes.** Max Meirowsky, 321, High Holborn, London. (Complete specification.)

12499. **Improvements in holders for electric lamps.** Ernest Albert Browning, 12, St. Andrew-square, Edinburgh.

12521. **Improvements in and connected with the electrolysis of oxides, salts, and other compounds.** Joseph Baxeres Torres, 17, St. Anne's-court, Wardour-street, London

12533. **Improvements in electrical alarm devices for steam and other gauges.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (William Henry Bradt and Melville Marble, United States.) (Complete specification.)

12546. **Improvements in electricity meters** Chamberlain and Hookham, Limited, and Sydney Holmwood Holden, 18, Southampton buildings, Chancery-lane, London.

JUNE 29.

12596. **Improvements in apparatus for automatically governing electric transformers.** Anthony George New and Arthur James Mayne, 55, Chancery-lane, London.

12613. **Improvements in or connected with electric railways or electric transport.** James Grieve Lorrain, Norfolk House, Norfolk-street, London. (Frederick C. Esmond, United States.)

12614. **Improvements in or connected with electric railways or electric transport.** James Grieve Lorrain, Norfolk House, Norfolk-street, London. (Frederick C. Esmond, United States.)

12615. **Improvements in or connected with electric railways or electric transport.** James Grieve Lorrain, Norfolk House, Norfolk-street, London. (Frederick C. Esmond, United States.)

12616. **Improvements in or connected with electric railways or electric transport.** James Grieve Lorrain, Norfolk House, Norfolk-street, London. (Frederick C. Esmond, United States.)

12617. **Improvements in or connected with electric railways or electric transport.** James Grieve Lorrain, Norfolk House, Norfolk-street, London. (Frederick C. Esmond, United States.)

12622. **Improvements in secondary or accumulator cells.** Adolph Müller, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1893.

3412. **Transmitting signals through cables.** Muirhead and Saunders. (Second edition.)

1894.

11069. **Transmitting signals through telegraph cables.** Muir head. (Second edition.)

11241. **Electric lamp.** Boardman.

11559. **Magneto-electric motors.** Lüdeke and others.

12304. **Electric telephone systems.** Frenay-Olyff.

12476. **Electric switching and regulating apparatus.** Raworth.

13082 **Erecting telephonic, etc., wires.** Shore.

14847. **Electric batteries.** Liardet.

14987. **Electrolysis of alkaline salts.** Wise. (Solvay and Co.)

17379 **Electric elevators or cranes.** Willcox. (Eisenwerk vormals Nagel and Kaemp Actien Gesellschaft.)

20807. **Telegraph transmitters.** Taylor.

24613. **Electric signalling system.** Hall.

1895.

5747. **Dynamometers.** Perkins.

7086. **Electric switch.** Russell and Officer.

7649. **Arc lamps.** Crosby and Shaw.

7668. **Electric distribution.** Devonshire. (Rice.)

7673. **Incandescent lamps.** Friedländer and Müller.

8834. **Electric traction.** Lindner and Van Sweevelt.

9010. **Electric railways.** Baird.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅛-5⅜
Brush Company, Ordinary	3	2⅛-2¼
—— Nom. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5⅛-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	16-16½
—— 5 per cent. Debenture Stock	100	131-134 xd
City and South London Railway, Consolidated Ordinary	100	42-44
—— 4 per cent. Debenture Stock	100	132-134
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A 1-200 of £50	100	—
Electric Construction, Limited	2	¾-1
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	1⅞-2⅛
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1-1⅛
Elmore's Wire Company	2	1⅛-1⅜
Fowler-Waring Cables	5	⅞-1
W. T. Henley's Telegraph Works, Ordinary	10	10¾-11½
—— 7 per cent. Preference	10	14-15
—— 4½ per cent. Debentures	100	104-107
House-to-House Company, Ordinary	5	3¾-4
—— 7 per cent. Preference	5	7¼-7½
India Rubber and Gutta Percha Works	10	20-22
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7-7⅛
—— 6 per cent. Pref.	5	7-7⅛
Liverpool Electric Supply, Ordinary	5	7⅛-7⅜
—— Pref.	—	—
Liverpool Overhead Railway	10	9 15/16-10 1/16
—— Pref.	10	14⅛-15½
—— 4 per cent. Mortgage Debentures of £100	100	110-112
London Electric	5	⅛-⅜
Metropolitan Electric Supply	10	10½-11
—— 4½ per cent. First Mortgage Debenture Stock	100	115-117 xd
National Telephone, Ordinary	5	5⅝-5⅞
—— 6 per cent. Cum. First Pref.	10	15½-16½
—— 6 per cent. Cum. Second Pref.	10	14½-15½
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-6⅛
—— 3½ per cent. Deb. Stock	100	105-107 xd
Notting Hill Company	10	8-8½
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7-7⅛
—— £4½ shares	4½	5⅛-6⅛
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8½-8⅞
—— 7 per cent. Pref.	5	9-9½
Swan United Ordinary	3	1⅞-2⅛
—— 4½ per cent. Debentures	100	104-107 xd
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	104-107 xd
Waterloo and City Railway, Ordinary	4	4⅜-4⅝ xd
Westminster Electric Supply, Ordinary	5	7⅞-8⅛
Yorkshire House-to-House	5	5⅛-5⅜

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NOTES.

Quadruple Telegraphy.—We have received a reprint from the *Elektrotechnische Zeitschrift* of a paper read by Herr Jul. H. West, before the Elektrotechnische Verein in March last, on the subject of quadruple telegraphy in America.

Correction.—In the reply of M. Jean Rey *re* "The Qualities of Mangin and Parabolic Mirrors," published in our issue of July 5, the following correction should be made—viz., page 8, line 25, for "mirror of 30cm." read "mirror of 60cm."

"Mining News."—This is the heading which the new financial daily, the *Financial Post*, gives to an item relative to the dividend of the Capetown Electric Lighting Syndicate. Like most journals in their infantine stage, our contemporary is somewhat erratic.

Personal.—Prof. Henry Spooner, C.E., director of the department of mechanical engineering at the Royal Polytechnic, has been appointed by King Alexander of Servia to be a Knight Commander of the Royal Order of St. Sava, as a recognition of his labours in the cause of science. Prof. Spooner is the author of several works in relation to geometry and mechanics.

The Effects of Gas.—At the North London Police Court the other day, Joseph Triggs, aged 46, compositor, of Walsingham-road, who was found drunk in Stoke Newington-road, excused himself on the ground that in the office where he had been at work all night the electric light had broken down; the gas was put on, which made the air so oppressive. He was discharged.

Corruption ?—Considerable stir has been created in Galatz, in connection with the recent adjudication of the construction of the electric tramways in that city to the firm of Georgi and Co., by the arrest of two persons holding high positions on a charge of corruption. What the precise nature of the charge is we are not yet in a position to say, but it is thought to refer to alleged malversation of deposit-money.

Chesterfield Institution of Engineers. — The annual general meeting of the Chesterfield and Midland Counties Institution of Engineers is to be held to-morrow (Saturday) at the Court House, Warwick. There are now 14 honorary members, 10 life members, 224 members, two associate-members, 73 associates, and 27 students belonging to the institution. The bank balance and invested fund amount to £475.

The Jungfrau Railway Project.—The scheme for the construction of a railway up the Jungfrau seems to have at last assumed tangible shape. It is said that a considerable part of the capital of 9,000,000f. of the new company has already been subscribed, and that an Austrian firm has engaged to take shares and bonds to the value of 5,000,000f. on condition of receiving the contract for the electrical portion of the works.

Electro-Athletics.—Electrical engineers were worthily represented at the amateur athletic championship held at Stamford Bridge Grounds, S.W., on Saturday, the 6th inst., when the third and fourth places in the high jump championship were respectively secured by Mr. R. G. Perry, of Messrs. Crompton and Co., and Mr. W. E. Lane, of the Brush Company, both these gentlemen being awarded the standard medal of the Amateur Athletic Association.

Formation of Ozone by the Action of Electric Oscillations.—Messrs. E. Wiedemann and G. C. Schmidt, in *Ann. Phys. Chem.*, show that if, in the preparation of ozone by the influence of the silent discharge, means are adopted to obtain oscillations of a regular periodic nature, the yield of ozone is increased. They, however, only worked at low pressures where the yield of ozone was small—namely, 0·12 per cent.—under the most favourable conditions.

Electric Tramways in St. Petersburg.—The municipal authorities of St. Petersburg seem to have quite a British objection to tramways being worked by means of overhead conductors. They have just authorised the Prince Tenicheff Company, the *Novosti* says, to construct an electric tramway along the Vosnessensky-Prospect, Erbsen-street, and the Kasanskaya, but only on the condition that the cars are driven by current obtained from accumulators placed in the vehicles.

Hunting Tigers by the Electric Light. — A sportsman reports from Calcutta that he uses the electric light in hunting tigers at night. He sits on a raised platform in the jungle and suspends a 5-c.p. incandescent lamp over the bait, which is placed about 30ft. away. Batteries supply current for the light. A switch on the hunter's rifle enables him to throw on the light when he is ready to shoot. The light tends to temporarily blind the tiger, and a good shot can be had before his eyes become accustomed to it.

Books Received.—We have received from Mr. Henry Sell, 167, Fleet-street, E.C., the June supplement of his registered telegraphic addresses, which supplements and corrects the information supplied to his subscribers up to and including May 31 for London and May 9 for the provinces. By permission of the Postmaster-General, Mr. Sell is now able to state the trade or profession of firms in the alphabetical lists, and he will be pleased to add this information in his next edition without charge if firms will inform him what their business is.

Electricity on the Japanese War Vessels.—The Japanese Legation in Paris has forwarded to the French Government a report relating to the recent naval combats, in which it is stated, with regard to the electric installations on board the Mikado's warships, that the interruptions of current which took place were not caused, as has been said, by the recoil of the guns, but by the bursting of Chinese shells. The working of the ordnance manœuvred by electricity was not interfered with. The electric wires used for igniting charges were, however, broken by the vibration set up by the firing of the heavy guns.

German Activity in Italy.—We stated last week that Italy seemed to be at present offering the best field for the development of German electrical enterprise. It is now announced that the Berlin concern which is popularly known as the "Allgemeine" has, in conjunction with Swiss firms under the leadership of the Schweizerische Credit-anstalt and with several Italian banking houses, founded at Zürich a syndicate, entitled "Bank für Elektrische Unternehmungen (Bank for Electrical Undertakings)," which has for its object the buying out of Genoese electrical companies and practically monopolising the supply of current for both lighting and traction purposes in Genoa.

Electrical Taxation in Italy.—In its issue of June 30, *L'Elettricità* gives some particulars of the legislative Bill which proposes to tax gaslight and electrical energy for illuminating and heating purposes in Italy. It consists of eight articles, and promulgates an impost of 2 centesimi per cubic metre of coal-distilled gas, of 8 centesimi per cubic meter of oil-distilled gas, and of 0 60 centesimo per hecto-watt-hour of electrical energy. The consumption for

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municipal lighting of public areas and for motive power is exempted from the tax. The impost would have to be paid to the State by the supplier upon the quantity of gas or electrical energy furnished to the consumers, he having the right to recover from the latter the amount disbursed.

East London Trades Exhibition.—An exhibition is being organised, under the honorary presidency of H.R.H. the Prince of Wales, in connection with the People's Palace, and will be opened in March, 1896. The classification includes the usual section of an industrial exhibition, but a special feature of the exhibition is that separate sections have been arranged for the work of individual craftsmen, students, and apprentices, and for collective exhibits from polytechnics and other similar institutions. A liberal schedule of prizes has been arranged in these sections. A special section is also being arranged for women's work. The prizes in this section are not yet announced. The committee are also desirous of forming a loan exhibition of works of art.

Obituary.—Mr. J. B. Stearns died at Camden, Maine, U.S.A., on the 5th inst., aged 65 years. Mr. Stearns will be chiefly remembered in connection with the practical application of the duplex system of signalling in telegraphy. He showed how capacity could be added to the artificial circuit by means of condensers in such a way as to successfully balance the static capacity of the line. This made the duplex system a practical and workable system. He visited this country in the early seventies, and the result was the adoption of his system of balancing by the Post Office Telegraph Department in 1873. By means of this system the Department was enabled to work long circuits as duplex circuits, whereas before it had only been possible to apply duplex working to short lines having small capacity.

A New Asynchronous Alternating-Current Motor is described by Dr. Gustav Benischke in Heft 24 (1895) of the *Elektrotechnische Zeitschrift*. He says that the pretty experiments which E. Thomson made in Paris, and V. v. Lang in Vienna, in connection with the phenomena of reciprocal induction and electrodynamic screen effects, are well known. Stefan, he observes, had previously at one of his lectures at the University of Vienna given an interesting demonstration with rapid electrical alternations in conjunction with the Hertz experiments, and deduced therefrom his principle of the smallest magnetic energy. It is upon this principle that Dr. Benischke has constructed an alternating-current machine which yields power at any number of revolutions and goes by itself at any load without starting apparatus. This, Dr. Benischke claims, has not been attained before, even by the Brown motors.

Are You There?—A lunar enthusiast, Mr. Newton Harrison, winds up a thrilling article on "Telephoning to the Moon" in this fashion: "To build apparatus to carry on an experiment of so interesting a nature would necessitate the use of a gigantic coil mounted vertically with its axis in line with the moon. By the use of currents that continually reverse it is possible to project waves into the planetary regions to an inconceivable distance. These wonderful vibrations will strike the moon, embrace it in every part, and give rise with every timed change to a gentle hum. If lives exist on the lunar surface, if the murmur from the earth be heard, they will listen with sadness; they will feel that utter despair that brooks no consolation and stretches out its arms in vain." Mr. Newton Harrison, it is perhaps superfluous to remark, discloses his nationality by his pen. We have heard about that "despair that stretches out its arms in vain" before.

The Telephone Enquiry.—The Select Committee of the House of Commons appointed to consider and report whether the provision now made for the telephone service in local areas is adequate, and whether it is expedient to supplement or improve this provision either by the granting of licenses to local authorities or otherwise, have agreed to the following report, which has just been published: "Your committee have examined numerous witnesses upon the matter referred to them, and have completed their evidence, but have not, in view of the approaching dissolution of Parliament, had sufficient time to consider their report. They have therefore agreed to report the evidence they have taken to the House, and to recommend that a committee on the same subject be appointed in the next session of Parliament to consider and report upon the evidence already taken, and, if necessary, to take further evidence."

For the Paris Exhibition.—M. Devic's scheme for the construction, in time for the Paris Exhibition of 1900, of a revolving bridge, worked by electricity, over the Seine is discussed in the *Journal de l'Electricité*. There would be one central pier, opposite the Esplanade des Invalides, upon which would be pivoted an enormous platform, 136 metres in diameter, connecting the two banks of the river. In the middle of the platform a tower would be built containing cafés and restaurants. A central pivot would support the whole system, in the manner of hydraulic presses, and powerful screw-cranes would serve to raise the structure in order to put the crown in contact with the drums. The impulse to the bridge would be given on each bank by means of 24 rollers, actuated by dynamos, working by friction against the walls of the span. The rotation of the platform would be sufficiently gentle to enable passengers to step on and off it without any trouble.

Measuring Specific Inductive Power.—A new method of measuring specific inductive power has been described by M. Nodon and Prof. Pellat. They employed two metallic spheres of small capacity, placed some distance apart, and connected with an induction coil, and a third, movable, sphere grounded through a telephone. This third sphere is placed between the other two, its position being determined by the point at which no sound is heard through the telephone. The dielectric to be tested is placed between one of the stationary spheres and the movable one, and the latter is moved towards the dielectric until the telephone again becomes silent. The distance between the first and second positions of the movable sphere will then be proportional to the specific inductive power of the dielectric. In using the apparatus, a material whose inductive capacity is known is first employed; the unknown substance is tested from this or a standard. The two specific inductive capacities will be directly proportional to the distances found in the two tests.

Competitions.—The Société Industrielle du Nord de la France offers various premiums—gold, silver, and bronze medals—for the best treatises on certain set themes; competitions to be forwarded to the society before October 1. Prizes will be awarded for the most meritorious papers on the following subjects: The different systems of lifts and elevators, the author to indicate the best methods of avoiding accidents; the different systems of high-speed French and foreign railway locomotives; the construction and working of tramways; the industrial applications of electricity to the transmission of energy, the production of light, and traction; the applications of telephonic apparatus; electrometallurgy; the applications of electricity to the direct driving of machinery in workshops; comparison between the different modes of lighting; the specifications used in France and abroad for industrial electric installations, the author to prepare draft of a new form; the preparation and textile application of ozone; electric bleaching; and the applications of electricity

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to the manufacture of the various products of the chemical industry.

The Telephone in Sweden.—The Swedish State telephone authorities are, according to the *Daily News*, about to combine the telephone with the State telegraph system. In Sweden everybody is "on the telephone." In future every subscriber will be allowed to make use of his telephone address as his telegraph address. The letters "Rt" (Rikstelefon) will be transmitted free of charge, and the telegraph office receiving a message will look up the addressee in the telephone register and send it on. This will save two or three words in every telegram. Further than this, telephone subscribers will be allowed to telephone on their messages to the telegraph offices for transmission, and they can, if they so desire, have their telegrams telephoned on to their house immediately they arrive at the station. The State hopes to save by this arrangement, as the number of messengers will be reduced. They also hope to do an increased telegraph traffic.

Concentric Mains.—At the recent hundredth meeting of the Société Internationale des Electriciens, M. Grosselin read a paper in which he asked the question whether it was necessary to insulate the outside conductor with reference to the earth, or if it were preferable to put it directly in the earth, according to the English method. In Europe, the author said, it is customary to give this exterior conductor an insulation equal to the half or the third of that required for the interior conductor. Experiments made in the Champs-Elysées district have shown that this insulation was insufficient, and that a difference of potential of 3,000 volts existed between the conductors and between the interior conductor and the earth, but was nil between the outside conductor and the earth. The insulation of the exterior conductor then, the author continued, seems useless. The question has already been studied by Herr Neustadt, of Vienna, who has observed on a network on which alternating currents were being supplied at 2,000 volts, that the exterior insulation always fractured at the moment of the opening and closing of the switches. The conclusion he arrived at, therefore, was that it was not necessary to insulate the outside conductor.

The "Austria" Accumulator. — A new lead accumulator, for which great things are claimed, has recently been tested and apparently favourably reported upon by the Imperial Physical-Technical Institute, Berlin. It was made by the "Austria" Accumulatoren-Gesellschaft W. Engl and Co., of Vienna, and it consisted of six negative and five positive plates 20cm. long, 16cm. wide, and 6mm. thick. The plates were in a transparent celluloid vessel, closed on all sides, out of which they could not be taken without destroying the latter. The vessel was 25cm. high, 13cm. wide, and 17cm. long, and it weighed, with plates and acid, 14·5kg., or 31·9lb. The capacity of the battery was shown to be 26·7 ampere-hours per kilogramme weight of plate. The Vienna *Zeitschrift für Electrotechnik* contents itself with reproducing in full the German official report, with which it seems impressed, promising to return to the subject later. The Berlin *Elektrotechnischer Anzeiger*, on the other hand, besides publishing the complete report, indulges in a detailed and unfavourable criticism of it, and blames the Imperial Technical Institute for issuing bare statements of actualities without drawing conclusions therefrom.

Arc-Lamp Reflectors. — Some shops, especially jewellery establishments, make a practice of enclosing their arc lamps in globes, a portion of the interior of which is silvered in order to serve as a reflector and concentrate the luminous rays upon a particular spot. A lamp thus placed and fixed outside a shop in Havre began, soon after it was put in position, to cause uneasiness to the management. At the end of every half-hour it went out for a few seconds, and then burned as brilliantly as ever, and it was found that this rapid and regular extinction coincided with the fall to the bottom of the globe of a fragment of carbon pencil about an inch long. Ordinary methods failed to discover the cause of the fault and the abnormal combustion of the carbons. Closer investigation, however, disclosed the mystery. The arc was formed a little below the centre of the globe; the focus of the luminous rays reflected on the silvered part of the sphere was directed somewhat above the middle, on to the positive carbon, which, in consequence of the excessive temperature engendered, commenced to waste away in the manner indicated, and ended by detaching itself in small pieces. When re-illumination automatically followed, the previous conditions were reproduced, and half an hour later the same process of breakage, extinction, and relighting was gone through. Acting upon the lesson thus taught, the management of the establishment replaced the reflecting globes by cylindrical reflectors of parabolic section, and the lamps then worked smoothly.

Standard Resistances for Strong Currents.—The new standard resistances of the Berlin Reichsanstalt for measuring large currents by the voltage at the terminals of a known resistance, are described by Dr. Feussner in the *Electrotechnische Zeitschrift*. The first resistance has a value of 100 microhms, and can be used for currents up to several hundred amperes, and for a short time up to 1,000; the second resistance has a value of 10 microhms and is intended for currents up to 10,000 amperes. Instead of the usual bands of metal, these resistances are made of a casting of manganin in the form of a short hollow cylinder, having about the same width as its diameter, and having a thick wall, about equal to a little less than one-third of its outside diameter; numerous holes are drilled through it, parallel to the axis, so as so increase the resistance to the desired amount, and to serve for the circulation of the oil in the bath in which the cylinders are placed. The connectors are made of large copper bars inserted in two holes, parallel to the axis and diametrically opposite to each other, the current therefore flowing through the two halves of the manganin ring in multiple; these terminals are carefully soldered with silver. The connections for the voltmeter are made of manganin strips screwed to the cylinder near where the copper leads enter it, and are soldered with tin. Great care is taken to have the leads sufficiently large; those in the small apparatus are made of round copper bars 15mm. (about $\frac{5}{8}$in.) in diameter, and in the large one about 50mm. (about 2in.) in diameter, being a little less where they pass through the casting. It is not stated why the leads are not formed of manganin in the form of large blocks cast as a part of the original casting, to which the copper is then fastened; this would avoid all thermo-electric effects in that portion of the resistance which is used in the measurement.

Electric Dental Engine.—A dental engine has been patented by Mr. William E. Wheeler, of New York City. The armature runs vertically between the field magnets, its shaft being cone-shaped and fitted in a cone bearing at the lower end, while on its upper end a plane-face wheel, slightly dished in the centre, is detachably secured. At one side is a socket-like bracket, insulated from the motor body by rubber washers, and in the socket turns the vertical stem of a standard with which is connected a horizontal arm normally pressed downward by a spring. The outer end of the arm is bifurcated, and in the members are

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journaled the drill-operating spindle, on which is a friction wheel with a rubber rim contacting with the plane-face drive wheel on the upper end of the armature shaft. One of the members of the bifurcated arm has a downwardly bent extension adapted to engage a notched segmental support, and by lifting the arm and shifting the friction wheel toward the periphery of the drive wheel the speed is increased, while by shifting the friction wheel toward the axis of the drive wheel the speed is proportionately diminished. By moving the friction wheel to the opposite side of the drive wheel the direction of rotation is reversed, and when the friction wheel is held centrally over the dished portion of the drive wheel the rotation of the spindle ceases. A threaded extension on one of the bearing arms receives the internally-threaded sleeve, to which is secured the cable, in which is the flexible shaft of the drill, and on one side of the motor is an automatic switch and cable rest. It consists of a pair of spring clasp-like arms, with which are connected the + and – terminals of the circuit wire. The arms are separated when the cable is supported in the rest, the circuit then being broken and the motor stopped; but when the cable is lifted out of the rest, as would be the case when work is being done, the terminals contact, close the circuit, and set the motor in operation.

Moissan on Willson's Calcium Carbide.—M. Moissan, whose experiments with the electric furnace are well known, writes to the *Revue Générale des Sciences* to dispute the claim of Mr. Willson to priority for the commercial preparation of carbide of calcium by the same agency. M. Moissan states that his first research in an electric reverberating furnace with movable electrodes was published in the *Comptes Rendus* of December 12, 1892. In the first note he demonstrated the reduction by carbon, under the action of the electric arc, of oxides previously regarded as incapable of reduction. He referred principally to the reduction of the oxides of uranium, manganese, and chromium; but he also mentioned the accidental formation of calcium carbide by the action of vapours of calcium—the furnace being made of quicklime—upon the carbon electrodes. Mr. Willson's American patent is dated February 21, 1893, and is for the electric reduction of refractory metallic compounds. M. Moissan refrains from discussing the form of the Willson furnace, which reminds him of the Cowles and Grabau furnaces. He asserts that Mr. Willson has not in his furnace separated the calorific action of the arc from its electrolytic action. M. Moissan further declares that, whereas at first Mr. Willson regarded the formation of calcium carbide in his furnace as due to electrolytic action, in his later application for a German patent he affirms that it is a simple process of fusion. But M. Moissan's gravest impeachment of the Willson carbide of calcium process is, however, with reference to the question whether the products of reduction are obtained in the electric furnace in the fluid form or in that of powder. In the first Willson patent specification, it is insisted upon that sufficient carbon shall be employed to prevent the formation of a molten bath. Under this condition M. Moissan declares that it is impossible to obtain titanium, which Mr. Willson claims to have prepared. Finally, M. Moissan remarks that, in a patent treating particularly of alloys of aluminium and magnesium, the claim respecting calcium carbide and other products appears to him to be exaggerated, and to be merely a conventional covering phrase without value from the point of view of priority of discovery.

Technical Education.—The foundation stone of a technical school has been laid at Preston. The new school—the Victoria Jubilee Technical School it is to be named—will be an imposing structure, occupying a prominent position in Corporation-street. The architects selected by competition are Messrs. Cheers, Aspinall, and Smith, of London and Blackburn. It has not been deemed necessary to provide an art school or a chemical laboratory as the existing building (Harris Institute) provides ample accommodation in these respects; it also contains good classrooms, a large room (now used for technical classes in the building trades) capable of being fitted as a physical laboratory, and also an excellent lecture-room seated for about 200 students. The new building will contain a shed for weaving and designing, with space to accommodate 80 hand looms and 20 power looms; a preparation room for warping, winding, etc.; a room for drawing and colouring designs or patterns, and for cloth analysis; a textile museum, library, and reading-room; a shed to hold a complete set of machinery to show the processes of cotton spinning; a lecture-room to accommodate 200 students, mainly for classes in weaving and spinning; rooms for classes in mechanics and engineering, and machine and building construction; two rooms for apparatus and designs; one room each for carpentry and joinery, for appliances and practical work in the plumbing trade, and for instruction in electrical engineering. There are four extra classrooms, each to accommodate 50 students, and the necessary lavatories, cloakrooms, offices, etc., usually provided in a building of this kind. The building is capable of extension without the original arrangements being interfered with, and all the rooms are easily accessible. The rooms and corridors are to intercommunicate, are to be well lighted, well ventilated, and properly heated, and the corridors will be of ample width to allow space for the extension of designs, models, appliances, raw and manufactured materials, and for students' lockers. Provision will be made for the installation of the electric light through the building. The unoccupied land will be well laid out with shrubs, etc., and transformed into very pretty grounds, the whole to be fenced in with low wall and rails. The new building will cost upward of £16,000, and in addition there will be required a sum of money for fitting and furnishing it.

Temperatures of Transformation of Irons and Steels.—M. Charpy, in *Comptes Rendus*, in dealing with this subject, states that the metals were heated in a small furnace, the source of heat being a platinum wire, through which an electric current was passed, and the temperatures were automatically recorded by a Le Chatelier pyrometer. The table below gives the critical temperatures observed during heating and cooling, the critical points being distinguished by the letters a_1, a_2, a_3 used by Osmond. With these very soft steels, the point a_1, which is usually more marked the higher the proportion of carbon, is only feebly indicated, and the point a_3 varies greatly both with the nature of the metal and the rate of heating. The point a_2, on the other hand, is very constant and seems to indicate a distinctly reversible change, since it is produced at the same temperature during both heating and cooling. Arnold has also observed this constancy of the point a_2 in soft steels. Mechanical tests made after tempering indicate that the rectilinear break in the curve of extension disappears when the metal has been heated to 750—880deg. and then tempered. When the same steels are heated, after having been drawn in the cold, the curves as a rule are identical with those given by the annealed metal, and this is true also of the tempered metals, which indicates that the changes produced by tempering or hardening are not permanent in the cold and disappear on annealing at a temperature below the temperature of transformation. By rapid heating, however, curves were obtained in which the point 740deg. did not exist or was replaced by a con-

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vexity extending from 720deg. to 740deg. The facts observed show that the point a_1 (690—700deg.) corresponds with the transformation of the carbon estimated by Eggertz's method, a transformation which markedly increases the hardness of the steel; the point a_2 (740deg.) corresponds with the transformation of iron which is characterised by the rectilinear break in the curve of extension and which slightly modifies the magnetic and mechanical properties; the point a_3 (860deg.) corresponds with a second transformation of the iron which seems to affect more particularly the magnetic properties.

Steel containing	a_1.		a_2.		a_3.	
	Heating. deg.	Cooling. deg.	Heating. deg.	Cooling. deg.	Heating. deg.	Cooling. deg.
Carbon 0·07 per cent....	—	—	740	730	865	840
,, 0·09 ,, ..	722	664	744	731	903	860
Carbon 0·07 per cent., nickel 1·15 per cent.	710	698	744	732	835	—
Carbon 0·08 per cent., chromium 0·75 per cent.	—	675	744	744	860	789
Carbon 0·11 per cent., tungsten 0·60 per cent.	—	630	749	740	923	877

Twaddle.—The following, clipped from a non-technical exchange by an American contemporary, is a characteristic specimen of the literature which the public accepts as scientific on account of the jumble of scientific terms employed: "The time is fast coming when it will be easy to understand the physics of the breath of life, or of the oxygen of respiration, which is also the oxygen of combustion; how the inrush of oxygen by way of the capillary gates of the lungs, and the corpuscles of the blood, to the tissue cells of all parts of the system, carries a ceaseless volume of vital energy; how this animating and life-maintaining energy is nothing less than electricity of absolute dynamic strength and sureness—every breath, according to its size, a definite quantity of vitalising, heating, and sustaining energy; and how the flow and charge of this energy, in all parts of the system, will maintain functions and operate organs which it has, in fact, created. The knowledge from which we speak is not yet recognised because it is new, and belongs to a new system of nature so comprehensive as to require for its demonstration a survey for which the present teachers of science are not prepared, not even the most eminent of them. It requires long and elaborate research to bring into one view the facts of chemistry, of physics, of electricity and magnetism, of zoology, anatomy, physiology and botany, and of medicine and surgery, which fall into the demonstration that life is not, as the system now in vogue has it, 'a mysterious potency, always associated with a peculiar form of matter called protoplasm'; and which, 'so far as we know, has always resided, as it does to-day, in little masses of protoplasm, called cells' (Dr. T. Mitchell Prudden); but is the definite direct effect of a stream of electrical energy blown in the protoplasm by the oxygen of respiration; but in view of the whole history of science from Aristotle and Hippocrates to Darwin and Koch—in view of the long roll of demonstrated facts, and of the theories that have held on in the struggle of systems for existence, we may declare with the utmost confidence that the electrical function of the oxygen of respiration in all living things, animal and plant, and the electrical character of vitality in both animals and plants, is by far the surest and best demonstrated, as it is also by far the greatest and most comprehensive discovery the human mind has ever made—even if we take no note of the demonstration, which the system embraces, that all matter is electrically animated, however motionless it seems; that all atoms receive their character from the electrical charge which they carry; that all active properties and functions are electrically established; and that whatever motion exists anywhere in the material universe, from invisible particle to planet wheeling on its vast orbit in space, is due to electrical agency."

Weights and Measures.—The Select Committee appointed to enquire whether any, and what, changes in the present system of weights and measures should be adopted, have agreed to the following report: "They have, in the first place, received evidence from witnesses representing many different interests—(1) official, (2) commercial, (3) manufacturing, (4) trade, (5) educational, (6) professional. They have also received from numerous corporations, school boards, and other public bodies, resolutions without exception in favour of the adoption of the metrical system. Your committee find that almost all the witnesses express a strong opinion as to the complicated and unsatisfactory condition of our present weights and measures, and of the distinct and serious drawback to our commerce, especially our foreign trade, which this system entails, differing as it does from the system (metrical) now adopted by every European nation except ourselves and Russia, as well as by far the majority of non-European countries with which this kingdom trades. The evidence, however, goes further to show that not only is our foreign trade in every branch seriously handicapped, but that the home trade would be benefited if more simple and uniform standards of weights and measures than those now existing were adopted. Moreover, strong evidence was brought forward as to the serious loss of time incurred by English school-children in having to learn the complicated system of tables of existing weights and measures, and the urgent need of the adoption of a simpler system. It was stated that no less than one year's school time would be saved if the metrical system were taught in place of that now in use. Evidence from competent witnesses proved to the satisfaction of your committee that a compulsory change from an old and complicated system to the metrical had taken place in Germany, Norway and Sweden, Switzerland, Italy, and many other European countries without serious opposition or inconvenience; that this change was carried out in a comparatively short period; and that as soon as the simple character of the new system was understood it was appreciated by all classes of the population, and no attempt to use the old units or to return to the old system was made. In the United States, where a system founded on the English units exists, a commission is at present engaged in an investigation of the same character as that with which your committee is charged, and the Federal Government has this year passed an Act rendering the metrical system compulsory for pharmaceutical purposes. Your committee believes that the adoption of the metrical system by England would greatly tend to render that system universal. Your committee recommend: (*a*) that the metrical system of weights and measures be at once legalised for all purposes; (*b*) that after a lapse of two years the metrical system be rendered compulsory by Act of Parliament; (*c*) that the metrical system of weights and measures be taught in all public elementary schools as a necessary and integral part of arithmetic, and that decimals be introduced at an earlier period of the school curriculum than is the case at present." The Select Committee was constituted as follows: Sir John Barran, Mr. Burt, Mr. Crombie, Mr. Charles Fenwick, Mr. Alban Gibbs, Mr. Godson, Sir Edward Hill, Mr. Justin M'Carthy, Sir Samuel Montagu, Mr. Jasper More, Sir Albert Rollit, Sir Henry Roscoe, Mr. James Stevenson, Mr. Stewart Wallace, Mr. Webster, Mr. Whiteley, and Mr. Wrightson. Subsequently, however, Mr. Woods took the place of Mr Fenwick on the committee.

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THE ANNUAL MEETING OF THE VERBAND DEUTSCHER ELEKTROTECHNIKER AT MUNICH.

(BY OUR SPECIAL CORRESPONDENT.)

Acting on the instructions of the esteemed editor of the *Electrical Engineer*, I took a ticket to Munich on Tuesday last week with the view of representing that journal at the yearly gathering of German electrical engineers. My instructions were generally to find out the why and wherefore of the Verband, and the methods by which its objects are attained. I arrived at Munich on Wednesday evening and proceeded to the Rheinischer Hof, where I occupied a room adjoining that of the secretary of the Verband, Mr. Gisbert Kapp, late of Westminster, from whom I received a genial welcome. We breakfasted together on Thursday, the opening day. I found Mr. Kapp eager to get news of personal friends and professional colleagues in England. The first meeting of the general members of the Verband was held for reception purposes at 8 p.m. in the evening. This left a good deal of spare time to be pleasantly employed in exploring the art treasures of Munich. The evening function was held in the Arzbergerkeller, a large restaurant. There I obtained my membership ticket, with the useful additions of a handsome badge, an "Elektrotechniker Taschenbuch"—a neatly-bound note-book and diary containing information on general subjects relating to the profession, and a full programme—a guide to Munich, and a guide to the Starnberg district, which was visited by the members of the Verband on Sunday.

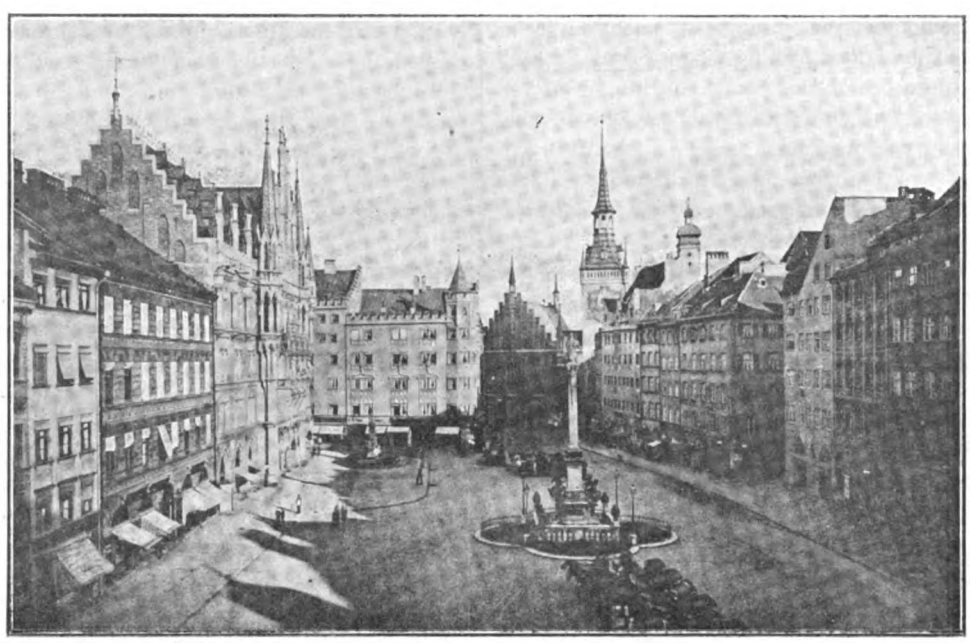
The meeting was held in a large room on the first floor of the Arzbergerkeller, which was decorated in a novel manner. Silver-birch trees newly cut down ornamented the walls, and in the centre of the tables handsome shrubs were placed at intervals. From these, festoons of edibles were hung in tempting proximity to the heads of the guests. Incandescent lamps were also placed in these shrubs, fed by flexible wires from the ceiling. My friend Mr. Kapp was engaged at a council meeting till late, and I had to pick up my acquaintances without introduction. A representative of the Helios Company (Mr. F. Heintz), however, kindly took me in hand. I had many introductions from him to noted German engineers who spoke my native language, amongst whom was Oscar von Millar, the engineer who is responsible for the design of so many German electric lighting stations.

The music provided was good, and the audience sang with great gusto the various topical songs that had been written for the occasion. Other amusements were furnished—such as a dialogue between a comet, a gas lamp, and an incandescent lamp with respect to their own merits as lighting media. The gentlemen with the incandescent lamp in his helmet looked as though he had walked out of the Zürich Incandescent Lamp Company's advertisement.

When I left the Arzbergerkeller, the birch trees and evergreen shrubs were almost all that was left of the decorations.

FRIDAY, JULY 5.

Before proceeding with the account of the meetings held on this day it may be of interest to recapitulate the general objects for which the Verband was established. The society was started in 1893 for the purpose of bringing German electrical engineers into closer contact, and ensuring a permanent representation and advancement of German electrical engineering. This end was to be attained by holding an annual meeting of the members of the society in a German town, which would promote the exchange of opinion on matters of current interest through the medium of papers and discussions, and by the publication of a journal, etc. The official home of the Verband is No. 3, Monbijou-Platz, Berlin. The president is Geh. Reg.-Rat. Prof. Dr. A. Slaby, of Charlottenburg; the vice-presidents are Herr Wilhelm von Siemens, of Charlottenburg, and Kgl. Baurat J. Stübben, of Cologne; the secretary is, as already stated, Herr Gisbert Kapp. Subject to the approval of the committee, any resident in Germany who has a scientific or practical interest in electrical engineering and the allied branches may become a member of the society, the annual subscription to which is 30 marks. There are now 1,600 members. The organ of the Verband, as most readers know, is the *Elektrotechnische Zeitschrift*.



Old and New Rathaus, Munich.

As might be expected in such a large society, friction has occurred, but I do not doubt personally that with careful attention from Mr. Kapp the Verband will be a power for good to the profession in Germany.

The annual report was presented on Friday morning, but the *Elektrotechnische Zeitschrift* has the first right of publication of it and of all the papers read at these meetings. I may, however, allude to the trouble arising over the new fire rules about to be issued by the Verband. The difficulty of devising entirely new wordings makes previous authors jealous. The result here has been that certain engineers object to the new rules, mostly, I gather from several sources, on personal grounds. One disciple of Mr. Musgrave Heaphy's, who introduced his own set of rules by translating those of the Phœnix Company, is a leader in the strife, and imitates his master's standing with regard to the rules about to be issued by the English Institution of Electrical Engineers.

One or two papers were read before the morning meeting closed, and I must commend the German method of

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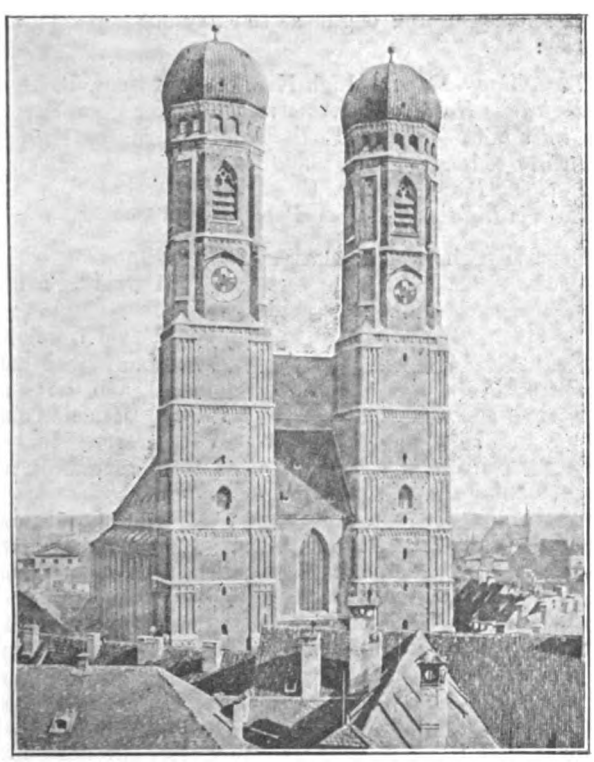
extempore speaking. Some of the authors had their papers to refer to; most had not. The result was a concise and brief account of the work contained in the written papers, given with a power that with reading is impossible. This feature and the condensation resulting might be adopted with much advantage by our institution. The

Triumphal Arch, Munich.

paper describing the Munich electricity works was amply illustrated with diagrams, drawings, and models, which were very interesting to all present.

At noon the ceremony of unveiling the statue of Ohm was much hampered by rain. A heavy thunderstorm drenched those of the spectators who were unable to obtain shelter. The statue, which is of white marble,



The Cathedral, Munich.

stands in the square in front of the Technical High School, near the celebrated old picture gallery. The rector of this school unveiled the statue after a suitable ode had been sung. A biographical sketch of Ohm was circulated among the members of the Verband. Georg Simon Ohm was born at Erlangen on March 16, 1789, the son of a master locksmith, who was himself able to initiate his sons in the mysteries of mathematics. Young Ohm's first post was as teacher of mathematics and physics in Gottstadt and Neuenberg, in Switzerland. Thence he returned to his native town, and acted as *privatdocent* at the university there for a short time. From here he wandered to Bamberg, then to Cologne, where, in 1827, he published his chief work, "The Galvanic Circuit Mathematically Elaborated." Later he became a professor at, and ultimately rector of, the Polytechnic School at Nuremberg. He was 60 years of age when he came to Munich, where he worked as a professor in the university and an academician until his death, which occurred on July 6, 1854. Ohm's discovery of the laws of the electric current was admittedly of the very highest importance; and when, in 1881, the electricians assembled in congress at Paris resolved to name after him the unit of electrical resistance, the theory of which he was the first to develop, they raised to him a "monument more lasting than brass," or even than that of marble, which has just been unveiled to him in his beloved "München."

(To be continued.)

SOME USES OF CURVES IN ELECTRICAL PRACTICE.

BY H. H. SIMMONS, A.I.E.E.

(Continued from page 9.)

We will not ourselves plot this curve any further, but will suppose the curve handed us as in Fig. 3. There

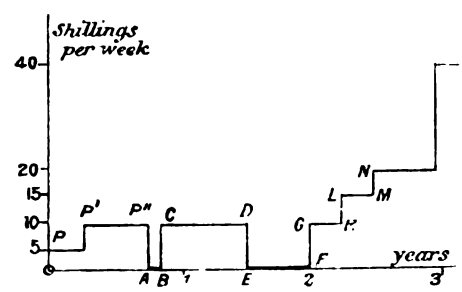


FIG. 3.

is a rumour abroad to the effect that a certain young electrician made use of such a curve when applying for a post, and, when asked what he had done previously, handed in his reply in the shape of a curve.

For obvious reasons of space, we must adopt a different scale in Fig. 3 from that used in Fig. 2. It is customary to append the necessary information as to scale and quantities plotted, in the manner shown in Fig. 3; in fact, Fig. 3 is complete in itself, and requires nothing to make it perfectly intelligible to anyone who understands a curve, or who has even read the first article of this series.

One of the best ways of attacking a curve is to tabulate all the points in the manner exemplified below. We first measure the length marked 10 on O Y, and find it to be 1cm., and the length marked 1 along O X we find to be 1in. All we have to do now is to measure the position of each point by finding its distance from O, first along O X and then along O Y.* Having put down the dimensions, we can at once translate them into the quantities represented.

Point.	Distance from O along O X = time			Distance from O along O Y = income.		
P	0	=	0	0·5cm.	=	5s. per week.
P'	¼in.	=	3 months.	1·0	=	10s. ,,
P''	¾	=	9 months.	1·0	=	10s. ,,
a	,,	=	,,	0	=	nothing.
b	⅔	=	10 months.	0	=	,,
c	,,	=	,,	1·0	=	10s. per week.
d	1½	=	18 months.	1·0	=	10s. ,,
e	,,	=	,,	0	=	nothing.
f	2	=	2 years.	0	=	,,
g	,,	=	,,	1·0	=	10s. per week.
l	2¼	=	2¼ years.	1·5	=	15s. ,,
n	2½	=	2½ years.	2·0	=	£1 ,,

* The horizontal direction will always be referred to as O X and the vertical as O Y.

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and so on. Of course, the parts of the curve, *a b* and *e f*, show times during which he was earning nothing, but they do not tell us why. We have to guess why; and here let me remark that it is commonly the duty of curves to show us facts of which we have by independent reasoning to arrive at the cause.

Briefly summarised, this curve, Fig. 3, says that this person started at 5s. a week, had his money doubled after three months, and remained at 10s. a week for 1½ years. He was away from work for a month of this time, and at the end of the time again for six months. Starting at the same wage again, he had a couple of 5s. rises in six months, and a £1 rise at the end of the next six months.

We will not proceed to the study of particular shapes of curves until we have looked at one more example. Let us take Fig. 4. In this we see space and time connected by a line. This curve has only one sharp point in it, and, when we think of what is represented, we can readily understand that sharp points would not occur. We are shown changes of space in corresponding changes of time, and, since we are measuring space from a given point it is plain that a motion is represented. Now, the motion of any body which has mass cannot change absolutely suddenly, the change must be more or less gradual. Let it be clear that length on this curve does not mean motion in the sense of velocity. Length up O Y means space, or distance passed through; and length along O X means time, again, as in Fig. 3: velocity can only be represented by considering both at once; but more of this later on; let us first read what appears on the surface of this curve.

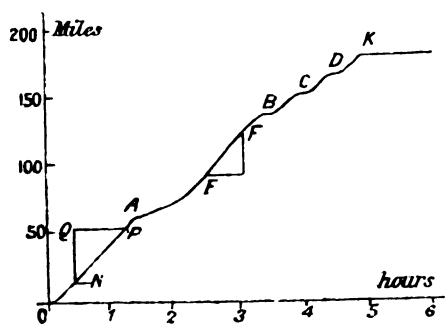

FIG. 4.

During the time, six hours, we see a change in position of 185 miles; on measuring the scale we find it ½in. to the hour and 1in. to 100 miles.

We see little flats in the curve at *a*, *b*, *c*, *d*, and a long one at K. What do they mean? At these points distance along O X increases, but not along O Y. From this we learn that time has increased, but distance has not; in brief, the body is at rest at these points and is not moving at all. Between *n* and *p* the curve is straight, and we find on measuring that *q n* and *q p* are each ½in.—that is to say, the change of length along the direction O Y is ½in., and the change of length along O X is ½in., so that the body has moved 50 miles in that hour, *q p*. If we measure at the points *e* and *f*, we shall find a change of ¼in. along O X, and ⅓in. along O Y, or a change of 33·3 miles in half an hour.

This curve might very well be the history of a certain railway journey, showing stoppages at *a*, *b*, *c*, and *d*; the steepness of the curve showing, as must now be apparent, the speed of the train. It is well, when looking at a curve of this sort, to be very careful indeed to remember that, although distance along O Y means distance in this case, distance along O X means *time*, and therefore this is not a map of the train's track; the train might have been going round a circle the whole time for aught the curve tells us on the point. "Distance travelled" and "time" are the quantities connected. If it were a map, distance north and distance east of the datum point would be what we measure along O Y and O X respectively.

Just a word about the sharp corner just before *k*; this shows a sudden change in the direction or steepness of the curve—that is, in velocity—and points to a collision, especially as it is followed by so long a stoppage.

A very great deal might be said about this curve with regard to the interpretation of its waviness, the meaning of which has been hinted at; but before going thoroughly into the examination of a curve representing physical facts, we must take up the study of a few common curves for their own sakes. This study is known as geometry—co-ordinate and analytical geometry—and may be read up in any of the numerous books on the subject. These articles are not designed to take the place and do the work of such books, but to treat of the subject only so far as is absolutely necessary for the handling of such curves as are to be commonly met with in practice, and that in an elementary, simple manner.

(To be continued.)

GLASGOW HARBOUR TUNNEL.

The Glasgow harbour tunnel, which was opened last week, will provide a means of cross-river communication in the middle of the harbour, where it has long been required; and as it will put the Queen Docks, on the north side of the river, into direct communication with the new Cumock Docks, on the south side, its advantage will be more felt when these latter docks are finished.

So much has the want of some means of communication between the extensive engineering works on the north side of the river and the south side been felt, that various schemes have been suggested of building high-level or swinging bridges with inclines to them; but the necessary stoppage of the river traffic for even a short time was recognised as an insurmountable obstacle to a bridge of any description, as most of the cross-channel steamers start from above this point.

It was left to Messrs. Simpson and Wilson, however, to put forward a scheme for constructing tunnels under the bed of the river, and the approaches to which, instead of being by means of inclines, was by lifts or elevators. The scheme was sanctioned by Parliament in 1890, and work was soon after commenced. The following contractors were selected by the engineers to carry out portion of the works:

Tunnelling—Messrs. Hugh Kennedy and Sons, Partick.
Hydraulic Hoists—The American Elevator Company.
Girder Work—Messrs. Findlay and Co., Motherwell.
Boilers—Messrs. Penman and Co.
Pumping Plant—Messrs. Cross, Haron, and Co.
Electric Lighting—Messrs. Paterson and Cooper.

Generally, the works consist of three tunnels—two for vehicular traffic and one for foot traffic. This latter tunnel, which is the centre one, is reached by stairs on either side of the river, while the other two run on a level from shaft to shaft.

These tunnels are 16ft. internal diameter, and the length from shaft to shaft is a little over 700ft. Both shafts are round and 76ft. in diameter and 75ft. deep. In each shaft there are six hydraulic hoists—three for lifting and three for lowering—but any one of them can be used for lifting or lowering when required; the maximum load to be lifted is about 5½ tons. The passenger tunnel pierces the shaft 34ft. from quay level with flights of stairs, as above mentioned, and thence descending by a gradient of 1 in 3, the same level as the other tunnels being reached at the quay walls. This arrangement with stairs in shaft and incline obviates the necessity of lifts for passengers.

We might here remark that the whole of the mechanical portion of the works has been carried out by Mr. D. H. Morton, M.I.M.E., A.M.I.C.E. Electric light necessarily plays an important part in such an undertaking as this; and one of the points that the engineers had in view in placing the contract for the work was that the installation should be of such a nature that the damp and moisture that has to be contended with should do no damage to the leads, etc. The usual methods that have met with more or less success were suggested, such as lead-covered cables, cables in iron pipes, etc., but Messrs. Paterson and Cooper, of London and Glasgow, suggested what might almost be called a modification of the Brooks system of town mains—

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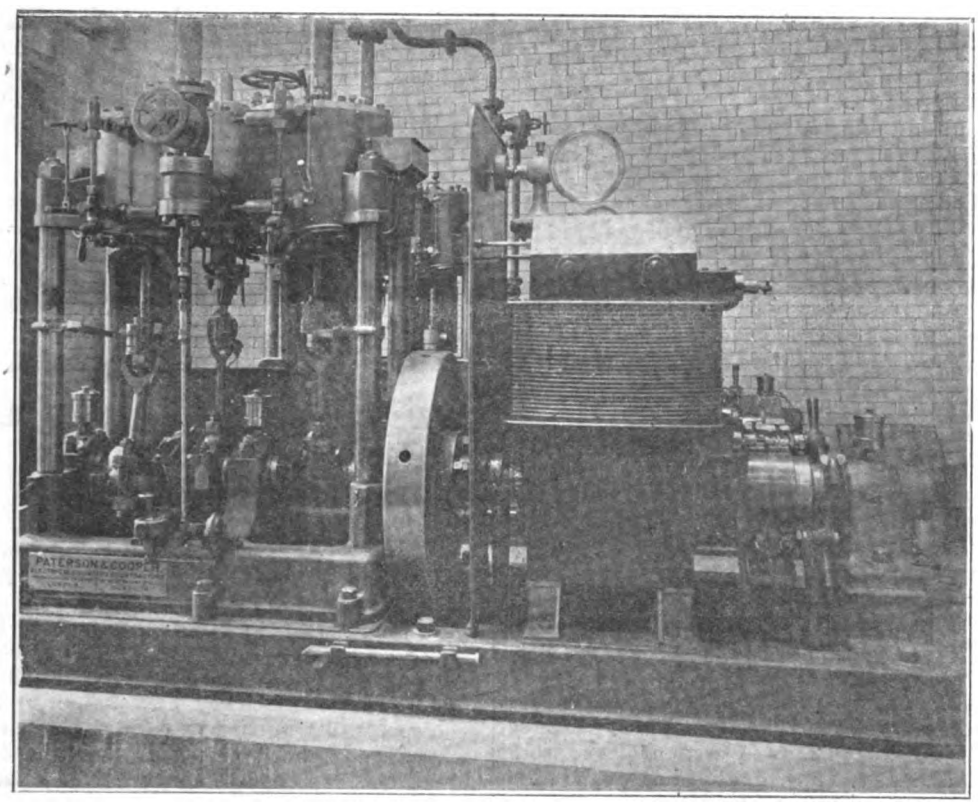
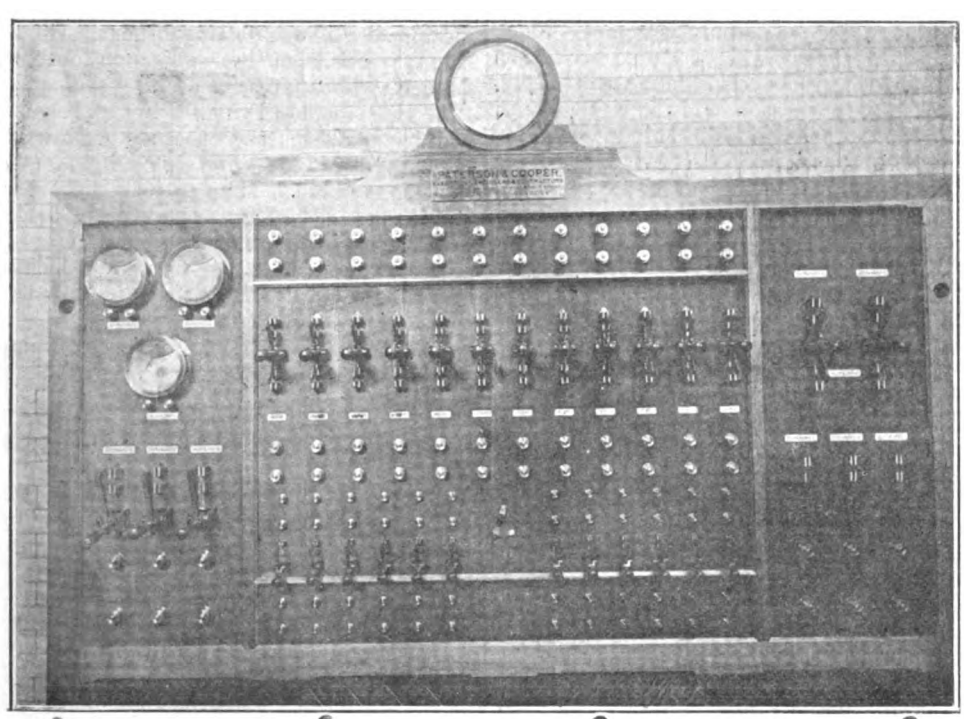
that is to say, to use specially-covered cables, run in iron pipe and filled entirely with a preparation of resin oil. It is obvious that by this means all possibility of damp reaching the wires was perfectly overcome; and we must congratulate the engineers upon adopting this system, as, although it is considerably more expensive than any other system, they have an installation that will practically last for ever.



Direct-Driven Dynamo.—Glasgow Harbour Works.

The plant consists of three sets of direct-coupled plant—two sets of 20,460-watt output each, and one small auxiliary set of 6,050-watt output. The plant is placed in the main engine-house, which contains also the pumping and lift plant, and is situated on the south side of the river. The two large sets of plant consist of inverted-type wrought-iron dynamos, coupled on to compound engines by G. H. Belliss and Co., of Birmingham. The dynamos, as will be seen in the accompanying illustration, are of the ordinary type. They give 186 amperes at 110 volts at 300 revolutions per minute, are compound wound, with the series winding on the outside. The armatures are of the improved Gramme ring type as now made by Messrs. Paterson and Cooper, and they run absolutely without sparking at the brushes. The engines are of the Belliss central-valve type, having cylinders 8½in. and 13in. diameter, and 6in. stroke. They indicate 34 h.p. with a steam pressure of 95lb. The governor is fitted direct on to the crankshaft, and controls the throttle. A variation of less than two volts only is experienced between full and no load,



Switchboard.—Glasgow Harbour Works.

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Special precautions are taken to ensure dry steam, drip pipes being fitted directly above each engine, besides the ones on the main branches. The small dynamo is exactly similar in construction to the other two, but has an output of only 55 amperes at 110 volts at 300 revolutions per minute. The engine is also by Belliss and Co., but is only a single-cylinder engine, but of the same type otherwise as the two compound engines. Tachometers are fitted on each of the sets of plant.

The switchboard—an illustration of which is given—is designed so as to effect the greatest economy in power with the greatest facility in manipulation. It consists of five slate tablets mounted in a pitch-pine frame. On the right-hand tablet are the three main positive dynamo switches and fuses, and also the throw-over switches to throw the auxiliary dynamo on in place of either of the two large sets when the load on the latter falls sufficiently. The left-hand tablet contains the main negative switches and fuses, and an ammeter for each dynamo. The top tablet contains the negative-circuit fuses, and the bottom tablet contains the negative arc lamp fuses. The centre tablet contains all the positive fuses, the arc lamp switch, and circuit throw-over switch.

The installation is divided into 11 circuits as follows, one spare circuit being provided for on the board: (1) north shaft A; (2) south shaft A; (3) north shaft B; (4) south shaft B; (5) foot tunnel A; (6) foot tunnel B; (7) east wheel tunnel A; (8) east wheel tunnel B; (9) west wheel tunnel A; (10) west wheel tunnel B; (11) engine-house, etc.; (12) spare.

The switches are arranged so that any circuit can be thrown on to either dynamo (whether it happens to be one of the main machines or the auxiliary plant that is being used). It will be noticed that every section of the work is in duplicate, so that the chance of a breakdown and total extinction of the light is very remote.

The duty of the various plants will be as follows. During the day, when the lights will be required only at the bottom of the shafts and through the three tunnels, one of the large sets will do the work. Then at night and morning, when there is not much traffic, and all the lifts are not required, the auxiliary plant will take up what the main plant cannot do; but when traffic is heavy, and all the outside lights are also wanted, both large sets will be at work. During the night, when only the foot tunnel will be open (the wheel tunnel will be closed to traffic between midnight and 5 a.m.), the small plant will easily do all the work. Should, however, one of the large plants be put out of use on account of overhauling, etc., the heaviest traffic could always be perfectly well carried on with the other two sets by switching off every alternate light in the tunnels, as it would still leave ample light for all practical purposes.

The lamps are distributed over the works as follows: north shaft, 10 arc lamps; south shaft, 10 arc lamps; foot tunnel, 50 32-c.p. lamps; east wheel tunnel, 25 32 c.p. lamps; west wheel tunnel, 25 33 c.p. lamps; engine-room, two arc lamps; pay-boxes, boilers, etc., 10 32-c.p. lamps. Total, 22 arc lamps, 110 32-c.p. incandescent lamps.

The arc lamps in the shafts are arranged as follows: one in centre of dome, four over the lifts, two at the bottom of shaft, one over the passenger staircase, one outside the passenger entrance, one outside the wheel-traffic entrance. The arrangement is the same in both shafts.

The lamps are of Messrs. Paterson and Cooper's well-known Phœnix type, and are arranged to burn two in series on the 110-volt circuit. Every pair of lamps in both shafts are controlled by switches on the main switchboard, although there are one or two other subsidiary switches placed on the starting platform under the control of the man in charge of the lifts.

The 10 mains for the arc lamps in the north shaft run under the floor of the passenger tunnel in a 3in. iron pipe, this pipe, as before mentioned, being filled with a preparation of resin oil. The oil-insulated mains in both shafts run to a terminal-box placed about 12ft. above the ground level on the side of the shaft; from these terminal-boxes ordinary 600-megohm vulcanised rubber-covered cables fixed on porcelain insulators run to the various lamps. In the foot tunnel the 50 lamps are arranged along the centre line, every alternate lamp being entirely on a separate circuit. In the wheel tunnels they are arranged alternately on either side.

The lamps in both cases are fitted in heavy enamelled cast-iron fittings with brass front and flint glasses, the whole made watertight with a rubber washer. These fittings have special joint-boxes of malleable iron attached to them through which the main pipes run, a specially-packed gland being fitted close to the lampholder to keep back the oil. Special bends, fuse-boxes, etc., are fitted to meet the requirements of the special form of insulation used. The cables being covered with a very absorbent material, great care had to be taken in getting the cable into the pipes that they were free from all moisture.

The whole of the installation was designed and carried out under the direct superintendence of Mr. E. George Tidd, A.I.E.E, A.M.I.C.E., Messrs. Paterson and Cooper's engineer and manager for Scotland.

ON A METHOD OF DETERMINING THE THERMAL CONDUCTIVITY OF METALS, WITH APPLICATIONS TO COPPER, SILVER, GOLD, AND PLATINUM.*

BY JAMES H. GRAY, M.A., B.SC.

Communicated by LORD KELVIN, P.R.S.

Of the different methods hitherto employed for the determination of thermal conductivity of metals, only those which were elaborated by Forbes and by Angström have been successful in giving absolute results with fair approach to accuracy. The two methods, in the hands of these and subsequent experimenters, have given closely concordant results, both for copper and for iron. They, however, possess the disadvantages of being exceedingly elaborate, requiring, as they do, very extensive preparations and comparatively large masses of the metals which are to be tested. For this reason only the less costly metals can be tested, as it would be impracticably expensive to obtain a bar of gold or platinum, for example, a metre or more in length, and perhaps two square centimetres section.

The method used in the present investigation (for which a grant of £50 was obtained from the Government Research Fund) is free from these objections. It was suggested by Lord Kelvin as far back as 30 years ago, about the same time that the late Principal Forbes began his experimental enquiry as to whether thermal conductivity varied with temperature. The chief advantages of this method are that (1) it is much simpler than the others; (2) a test of the conductivity of any metal can be made in two or three hours; and (3) (perhaps most important of all) only a few grammes of the metal are necessary. Thus, even the rarest and most expensive metals can be tested at very moderate cost.

The method is essentially the experimental realisation of the theoretical conditions implied in the fundamental formula—

$$Q = k\, A \frac{v - v_0}{l} t,$$

where the symbols have their usual meaning. The metals to be tested are made in the form of wires of circular section. One end is kept at a constant temperature, v, and the flow of heat, Q, in a given time, t, is measured. The length and section being known, all the data are obtained for the determination of the absolute value of the thermal conductivity. It will be noted that this value is the proper mean conductivity corresponding to the range of temperature between the ends of the wire.

Fig. 1 is a perspective drawing of the apparatus which has been used in the tests of this method. Fig. 2 is a section (all the parts being drawn quarter full size) containing the axis of the wire to be tested. Fig. 3 is a section, drawn full size, through the middle of the apparatus, in a plane perpendicular to the section in Fig. 2, and showing in greater detail the wire, calorimeter ball,

* From the *Philosophical Transactions* of the Royal Society of London.

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and that part of the heating-box at which the wire is soldered.

Referring to Fig. 2, W is the wire to be tested. The upper end of W is soldered into the bottom of the copper box, B, and the lower end into the solid copper ball, C, the diameter of which is 5·5cm. The sides of the copper box, B, are of thin sheet copper, and the bottom of copper, 3mm. thick. B is supported at the middle by being fitted

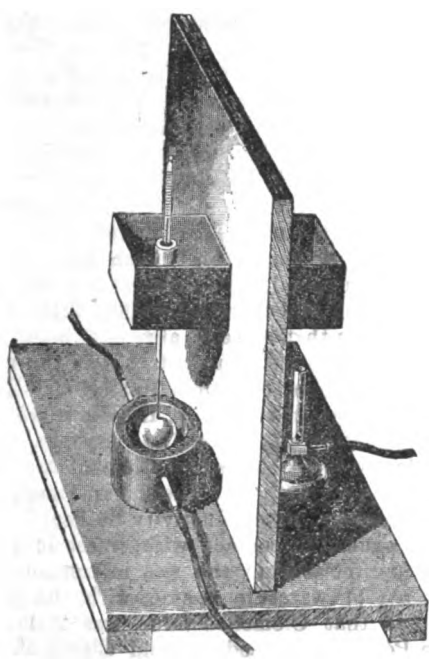

FIG. 1.

into a rectangular hole in a wooden screen, L, of dimensions 60cm. × 60cm. by 2cm. thick. In the hole of the copper block, K, a small thermometer is inserted for measuring the temperature of the other end of the wire. The box, B, is filled with water, and kept boiling briskly. The ball, C, is the calorimeter by which the amount of heat conducted by the wire, W, is measured. In order to measure the temperature of C, a very sensitive thermometer, which can be

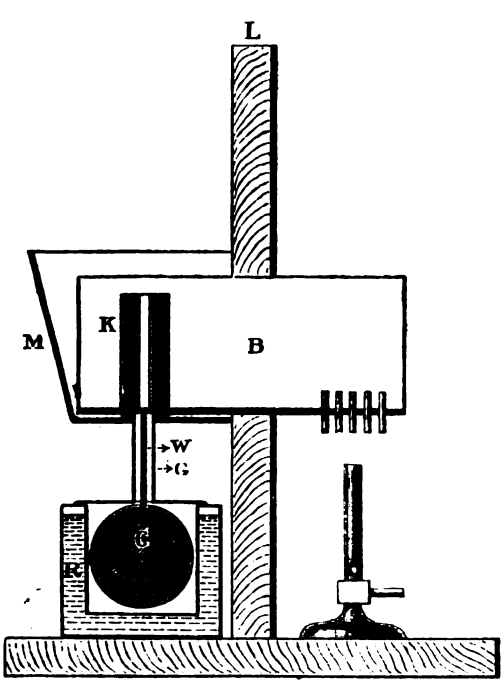

FIG. 2.

read to one-fortieth of a degree C., is inserted in a hole drilled in C. This hole reaches to a depth of 3·6cm. from the circumference of the ball. The bulb of the thermometer in the ball is surrounded by water or mercury. Surrounding the heating-box, B, is an asbestos covering, M, to prevent heat from reaching the calorimeter from the sides of the box. In order to keep the temperature of the air surrounding the calorimeter constant, the latter is surrounded by a water-jacket, R, through which water at the temperature of the air is kept circulating. This water-jacket is simply a cylindrical vessel, made of copper, with double walls, between which the water circulates. The inside diameter is about 1cm. greater than that of the ball. The top of the water-jacket is covered with three or four layers of paper, so that the air surrounding the ball is completely separated from the outside air, and is kept at a constant

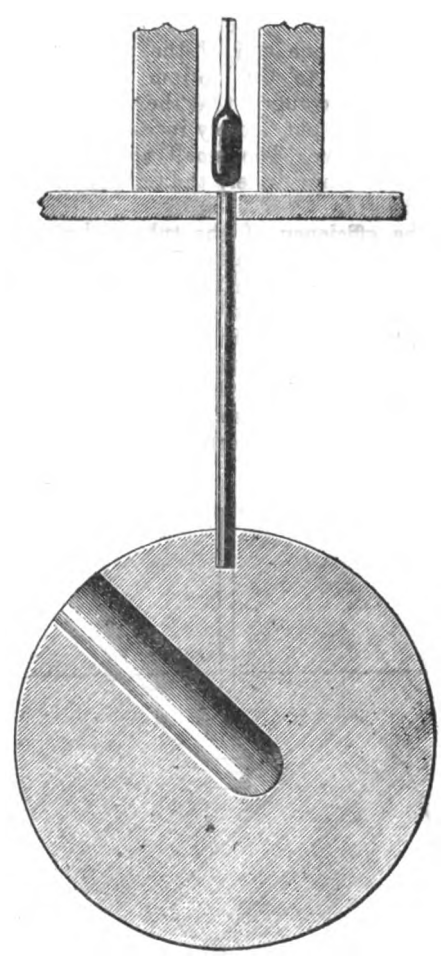

FIG. 3.

temperature. Surrounding the wire, all along its length, is a tube of cardboard, G, of inside diameter 1cm. Between the wire and the inside of the tube cotton wool is loosely packed, so as to prevent, as effectually as possible, circulation of air about the wire.

From Fig. 2 it will be seen that the heat from the Bunsen is prevented from reaching the wire or the ball by the wooden screen, L. In the bottom of the box, just above the Bunsen, are riveted a number of copper pins, so as to catch and distribute the heat of the burner. Fig. 4 shows a plan of the box.

It will be convenient to classify the sources of error that may affect the results, and to deal with them at this point: (1) There is, unless proper precautions be taken, loss of heat due to radiation from the surface of the wire, and therefore the value obtained for the conductivity will be too low. (2) The temperature indicated by the thermo-

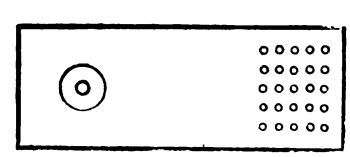

FIG. 4.

meter in the hot water may not be the same as that of the end of the wire at the point where it enters the box. Also, the temperature of the ball may not be the same throughout. (3) The thermometer may not indicate the average temperature throughout the ball. (4) There may be a lag in the thermometer. (5) There may be some error due to the solder at the ends of the wire.

1. Loss of heat due to radiation from the surface of the

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wire. As this was the most obvious source of error, a long time was spent and much work done in investigating it. The cardboard tube, G (Fig. 2), was found to be thoroughly efficient in preventing radiation. It can be very easily made by rolling a long strip of paper, which has been previously gummed on one side, several times round a circular rod of 1cm. diameter. The length of the tube is a little less than that of the wire. After the gum has dried, a slit sufficiently wide to admit the wire is cut parallel to the length. A circular piece of cardboard is fixed with gum to one end of the tube, as a flange for attaching the tube to the bottom of the heating-box. After it has been arranged that the wire is in the central line, cotton wool is put loosely in and the slit closed up with gummed paper. The small volume of air in this tube takes almost immediately the temperature of the wire all along its length.

To test the efficiency of the tube, a large number of experiments was made, the results of which are given further on. It is clear that for a given difference of temperature between the ends, the loss by radiation from the surface of a wire of given diameter will be greater the greater the length. If, then, there be no error which becomes less the greater the length, and thus compensates for the radiation error, a sufficient test of the efficiency of the tube will be to determine the conductivity with

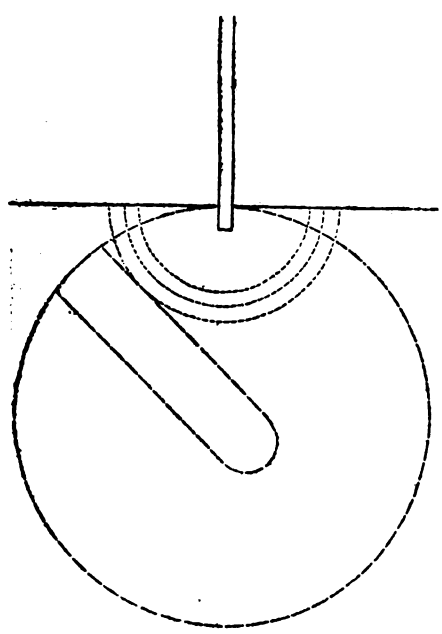

FIG. 5.

different lengths of the same wire. The shorter lengths ought to give a distinctly higher value, since the radiation from the surface is not only less than in the longer lengths, but the quantity of heat conducted along the wire per second is greater, and therefore the percentage error due to radiation rapidly diminishes.

In order to determine a superior limit for the error due to loss of heat by radiation, a calculation is made below. The numbers used are taken so as to be as unfavourable as possible, and give a value much higher than what would practically turn out. In the case of copper wire, the surface was always somewhat tarnished, so the emissivity may be taken as intermediate between those of polished and blackened copper—that is, ·0008. The diameter and length of wire were respectively ·2cm. and 4cm. The temperature at the hot end was 98deg. C., at the cold end 14deg. C. The curve of temperature along the wire being logarithmic, the mean temperature will be considerably less than half the sum of the highest and lowest temperatures, which would assume that the curve is a straight line passing through the highest and lowest points. Take, however, the curve to be a straight line; then the mean temperature above that of the air is 42deg. C. The quantity of heat, Q, lost from the surface, S, of emissivity, E, in one minute, is

$$Q = E S \times 42 \times 60$$
$$= 1{\cdot}91 \text{ C.G.S. units approximately.}$$

The quantity of heat conducted along the wire during this minute, as taken from one of the tests, was $\cdot 5 \times 68{\cdot}9$, ·5 being the rise in temperature, and 68·9 the capacity of the calorimeter. The maximum percentage error due to radiation in a length of 4cm. is, therefore, 5·5 per cent. This is on the assumption that there is no jacket round the wire, but even then the actual loss would probably be less than 3 per cent. if currents of air be avoided. This rough calculation shows that radiation from the surface of the wire need not be considered as an objection to the method.

2. Possible error due to the fact that the thermometers are not actually at the ends of the wire, and so may not be indicating the proper temperatures. The effect of this error would also be to give too low a value for the conductivity. To guard against this the bottom of the box is made very thick, and the large block, K (Fig. 2), is added so as to hold the thermometer. The difference of temperature between the inside and outside surfaces of the bottom of the box is certainly exceedingly small, if as much heat as the wire can take away is supplied to it. Since the heat is supplied by boiling water, it is, however, possible that the copper conducts so quickly that there is always a layer of water, it may be thin, immediately in contact with the metal at a very much lower temperature than 100deg. C. This point is particularly emphasised by Lord Kelvin in volume 3 of his "Collected Papers," where he remarks upon the exceedingly low values obtained by Clément and Péclet for the conductivity of copper. These experimenters both attempted to measure the conductivity by keeping one side of a slab of the metal in contact with water at a constant temperature and measuring the rise in temperature of a known quantity of water in contact with the other side. The result was that Clément's value was 200 times too small, while Péclet, who tried to avoid Clément's error by having the water violently stirred, succeeded in obtaining a value six times too small. With the large surface to carry away the heat, Péclet's method is useless for any substance having so high a conductivity as even the worst of the metals, since the stirring could never be rapid enough without introducing fresh complications. The direct tests applied to determine this error in the present investigation showed that the temperatures on the inside and outside of the bottom of the box were the same.

The following approximate calculation serves to show the order of magnitude of the error due to the assumption that the thermometer in the ball indicates the temperature of the end of the wire. It is clear that the difference of temperatures between the wire where it enters the ball, and the thermometer will be much less than that found as follows: Take the case of a wire carrying heat to an infinite block of metal whose surface is plane, and remark that the isothermals in the block would be hemispherical surface (Fig. 5) having for their common centre the point where the axis of the wire enters the ball, and suppose the flow of heat to be steady.

Let K = conductivity of the wire;
k = " " ball;
a = radius of the wire;
b = " " ball;

Then the quantity of heat that flows through any hemispherical surface distant r from the end of the wire is

$$Q = -k \frac{dv}{dr} 2\pi r^2;$$

and, since the flow is steady,

$$\frac{d}{dr}\left(-k \frac{dv}{dr} 2\pi r^2\right) = 0.$$

Hence $$r^2 \frac{dv}{dr} = C_1,$$

which gives $$v = C_1 r^{-1} + C_2.$$

For $r = a$ let $v = V$, and for $r = b$ let $v = \theta$.

Hence $$v = a\,b \frac{V - \theta}{b - a} r^{-1} + \frac{\theta b - V a}{b - a},$$

whence $$-\frac{dv}{dr} = ab \frac{V - \theta}{b - a} r^{-2};$$

and $$Q = 2\pi k \frac{V - \theta}{b - a} a\,b.$$

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Also $$Q=(V_1-V)\frac{\pi a^2 K}{l}$$

where V_1 is the temperature at the hot end of the wire, and l the length of the wire.

Since V is the temperature of the wire just where it enters the ball, and θ the temperature at the centre of the ball, $V-\theta$ is certainly much greater than the error, a superior limit to the magnitude of which we wish to ascertain. The heat which flows through the wire must be equal to that which flows into the ball; therefore

$$(V_1-V)\frac{\pi a^2 K}{l}=2\pi k\frac{V-\theta}{b-a}a\,b;$$

whence $$V-\theta=(V_1-V)\frac{a}{2l}\frac{K}{k}\frac{(b-a)}{b};$$

$$=-(V-\theta+\theta-V_1)\frac{a}{2l}\frac{K}{k}\frac{(b-a)}{b};$$

and, therefore,

$$V-\theta=(V_1-\theta)\frac{\frac{a}{2l}\frac{K}{k}\frac{(b-a)}{b}}{1+\frac{a}{2l}\frac{K}{k}\frac{(b-a)}{b}}.$$

In this case $V_1=100$deg. C., $\theta=15$deg. C., and, since the copper of the wire and ball were the same, $K/k=1$; $b=27$mm., $a=1$mm.

Take $l=8$cm.; then

$$V-\theta=85\,\frac{\frac{1}{160}\frac{26}{27}}{1+\frac{1}{160}\frac{26}{27}}\doteqdot\cdot5\text{deg. C.}$$

Take $l=3$cm., which is less than the shortest length used;

then $$V-\theta=85\,\frac{\frac{1}{60}\frac{26}{27}}{1+\frac{1}{60}\frac{26}{27}}\doteqdot1\cdot3\text{deg. C.}$$

Therefore 1·3deg. C. is greater than the extreme possible error made with the copper wire—that is, 1·3 in 85, or about 1·5 per cent.

Several attempts were made to obtain a direct test of this by applying a thermo-electric junction to the wire just at the point where it entered the ball. Owing, however, to the large mass of the ball which had to be heated, it was found most difficult to solder the thin wires of the theremo-electric junction at the required place, and, after several unsuccessful attempts, it was given up, as the indirect proof supplied by using different lengths of wire seemed quite satisfactory.

3. The thermometer in the ball may not indicate the average temperature. This also would be tested by using different lengths of wire, and, as will be seen, the results show that there was no substantial variation.

4. Lag in the thermometer which measures the rise in temperature of the ball. Here again different lengths will be a test. Also, in case that the water round the bulb of the thermometer caused the lag, mercury was substituted, but no difference in the result was obtained.

5. The solder at the ends did not cause any difference of value for different lengths. The method of conducting a test is as follows. Take a length of not more than 8cm. of the wire. As it is very easy to obtain any diameter, it will be convenient to have a hole bored in the bottom of the heating-box, just below the thermometer, of diameter rather more than 2mm., and depth 3mm. or 4mm. The heating-box must be brazed together, otherwise it is apt to fall to pieces when the wire is being soldered in. The latter process can be done with ordinary solder. The mass of copper in the box being considerable, it is rather a troublesome matter to solder the wire into it, as the whole box has to be heated. For this reason a soldering iron cannot be used. The box is most easily heated by a blow-pipe flame and the wire then inserted. The extra solder is then cleared off, so as to give a definite point from which to measure the length. After this end is fixed, the other end is soldered in a similar manner to the copper ball, and in the latter case fusible solder melting at about 100deg. C. will do quite well.

It was, however, found that the method of soldering just described, and used in this investigation, was very troublesome, and required some practice. If new apparatus were being made, it would certainly be much more convenient to make an alteration in this respect. The following plan would make the soldering of the wire a very easy process, instead of, as described, a difficult one. Six copper plugs, each of the shape shown in sectional elevation and plan in Fig. 6, might be made, 8mm. in length and 1cm. diameter, so as to screw into a corresponding hole in the bottom of the heating-box; and six similar plugs might be made for the ball. In each of the plugs the central hole might be made of a different diameter, varying from 2mm. to 4mm. In this way, wires of different diameters could very easily be soldered into the suitable plugs, which could then be screwed, first the one end into the ball, then the other end into the box. The two side holes shown in Fig. 6

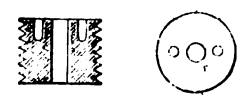

Fig. 6.

are for the purpose of facilitating the screwing in of the plugs. By screwing into the ball first, the possibility of twisting the wire is avoided. It is advisable not to use wire of diameter much less than 2mm., for, in wires of less diameter, the length required to give a readable rise of temperature per minute becomes inconveniently small, unless the calorimeter ball is made very small.

(To be continued.)

TRANSMISSION OF ENERGY BY THREE-PHASE CURRENTS WITH DOUBLE TRANSFORMING.

M. Julien Lefèvre has an article with this title in *L'Electricien* of June 8. He says although the use of multiphase currents is tolerably recent, there have already been a fair number of industrial applications of the system. The Compagnie de Fives-Lille has adopted three-phase currents for the transmission of energy. The dynamos producing these currents are not of any special design: they are of the same system as those of the Lauffen-Frankfort installation. They can be constructed for high-tension currents, but the company recommends rather the employment of low-tension machines, together with transformers. Thus the generator at the Lyons Exhibition gave 32,000 watts, at the speed of 750 revolutions a minute, with a frequency of 50 and a pressure of 120 volts between each principal conductor. The current thus produced is transformed up for transmission purposes, and reduced to low tension, on arrival, by a second transformer. As the transformers have a very high efficiency, the loss which results from this double transformation is insignificant. The transformers used consist of three vertical coils, the iron cores of which are connected at each end by yokes. Their magnetic circuits are thus closed, although only having one bobbin for each current, for each core serves as a return to the lines of induction of the other two. These apparatus do not take up much floor-space. In small types the two windings are superposed. From 60 kilowatts upwards each circuit is formed of coils in sections coupled in quantity for low tension, in series for high tension. The coils of the two windings alternate on the core and are carefully insulated by mica. The machine shown at Lyons was of 10 kilowatts, and designed to transform a pressure of 100 volts into one of 2,000 volts, and conversely. At the arrival station, the three-phase currents, after being converted to 100 volts by the second transformer, can operate special motors. The magnets of these apparatus have three sets of coils, producing a revolving magnetic field; the core of the armature is traversed by a series of copper bars, joined at each end by a copper ring. The Compagnie de Fives-Lille, in the installations which it carries out, feeds a number of small three-phase current motors from the lighting circuit.

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COMPARISONS.

Comparisons are odious, as we all know, but they have been made, are being made, and will be made, whatever may be said to the contrary. Comparisons are the sellers' stock-in-trade, and almost always misleading. Whatever arguments may be advanced against comparisons will have no practical effect, for usually the listener understands nothing of the technicalities of the subject under discussion, and has to accept the data to be compared from the speaker—generally, the would-be-seller. If the professor and the theorist only knew their business thoroughly, they would long ere this have provided almost every industry with standard theoretical data, together with standard practical data—the latter of which the practical man might hope to reach, the former never. Btween the theoretical and the practical a wide gulf lies—totally impassable. The seller buttonholes his man or his men and declaims volubly about what has been done by himself or his firm at so-and-so, carefully steering clear of the conditions that may exist at the place under discussion militating against so great a percentage of success, but pressing forward those conditions that tell in favour of his argument. We suppose it is almost or quite impossible to get an unbiassed authority to draw up standard data in certain directions for the purposes of comparison. To take a question only indirectly affecting the electrical industry where such data would seem to be easily obtained. We refer to the calorific value of refuse. In our last issue we had a paper on this subject, and the results there given differ so widely from those of other experimenters that at the meeting where the paper was read and discussed the want of standard data was referred to by several speakers. Last autumn the results of some experiments in refuse destruction gave a calorific value for the refuse greater than that of the best Welsh steam coal. Surely in this case it is not impossible to get standard data with which to compare results. Take the one figure—the average moisture of refuse. Is there no society or institution that can or will obtain this information? Then, again, what should be the temperature in the furnace? Is 1,200deg. F. sufficient, or is the work better done with 1,800deg. or 2,000deg.? What really is the temperature to be aimed at? We suggest that the Association of Municipal Engineers form a sub-committee to tabulate standard data with regard to refuse destruction. Then we should know the temperature of the gases leaving the furnace, and have some idea of how far this temperature could be degraded for utilisable purposes. Coming to something more directly interesting to electric light consumers, we may refer for a moment to the replacing of lamps. Why should canvassers hide the fact—or, rather, neglect to mention the fact—when touting for orders that a by no means negligible part of the cost of electric lighting will be found to consist of lamp renewals. A user of the electric light said the other day: "We have been greatly disappointed; we thought the lamps were practically everlasting, and no one indicated the contrary to us." What is a fairly good standard for lamp renewals? What, in

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fact, should users expect in this direction? Surely, it is best to be quite clear on this matter rather than to blur it over and allow opposing interests to intimate that electrical people are afraid of the truth, and wilfully keep back certain information from their customers. If we look in another direction, such as railway work, it will be found that engineers have tabulated results for many years, and may claim to have standard data with regard to the lasting properties of every part of a locomotive. They can tell you what should be the annual cost of maintenance of each item. We cannot see why electrical engineers should fear to give similar information. It has over and over again been cast in our teeth that we do not dwell lengthily upon the details of failures. It is not our place to do so, but the tabulation of failures and a general discussion upon failures would be of great value. Referring back to the question of lamp renewals. The customer ought to know that renewals are inevitable. He ought also to know the average cost of such renewal of particular lamps under his own running conditions, and the seller of electrical energy should be able to furnish that information. It may be said that such information means definite patronage of certain makers. Why not? Is there any hesitation about the wine merchant, or the glover, or the tailor, or the dressmaker in giving the names of their best wares, and why they deem them the best? What is the course pursued by electrical manufacturers? To the newspapers they say, "We won't advertise if you say your soul is your own and utter a favourable opinion about other folks' wares, or utter unfavourable opinions about ours." They make a trade ring, and the members of the ring scratch each other's backs and push each other's wares. Certainly, comparisons are odious, whether it be in regard to dynamos, systems, or finance. Gradually, no doubt, a better tone will prevail, and neither private consumers nor municipalities will be misled as to costs.

PRACTICAL NOTES ON DYNAMO CALCULATION.*

BY ALFRED E. WIENER.

(Continued from page 18.)

7. *Armature Resistance.*—From (31):

$$r_a = \frac{1}{4 \times 21} \times 1{,}075 \times .001144 = .0147 \text{ ohm at } 15{\cdot}58\text{ C.}$$

8. *Useful Flux.*—From (3):

$$\Phi = \frac{6 \times 515 \times 10^9}{2 \times 84 \times 400} = 46{,}000{,}000 \text{ webers} = 46 \text{ megawebers.}$$

9. *Radial Depth, Mean Cross-Section, and Average Magnetic Density of Armature Core.*—Taking a maximum density of 70,000 webers per square inch in the smallest cross-section of the armature core (see Table XVII.), formula (18) gives a radial depth of

$$b_a = \frac{46{,}000{,}000}{2 \times 70{,}000 \times 38 \times .9} = 9\tfrac{3}{4}\text{in.}$$

The maximum depth of the core, b'_a—that is, half the largest chord that can be drawn between the outer and inner core peripheries—can be obtained from Fig. 138:

$$b'_a = \sqrt{14^2 - 4\tfrac{1}{4}^2} = 13{\cdot}4\text{in.}$$

The mean sectional area of the armature core, therefore, is:

$$A_a = (9{\cdot}75 + 13{\cdot}4) \times 38 \times .9 = 792 \text{ square inches,}$$

and the average magnetic density in the armature core:

$$\mathfrak{B}_a = \frac{46{,}000{,}000}{792} = 58{,}000 \text{ webers per square inch.}$$

10. *Energy Losses in Armature.*—From (35) the $C^2 R$ loss is:

$$w_a = 1{\cdot}2 \times 600^2 \times .0147 = 6{,}350 \text{ watts.}$$

The frequency is $N_1 = \frac{400}{60} = 6{\cdot}67$ cycles per second.

The mass of the armature core, from (38):

$$M = \frac{18\tfrac{1}{4}'' \times \pi \times 38 \times 9\tfrac{3}{4} \times .9}{1{,}728} = 11 \text{ cubic feet.}$$

The hysteresis factor for $\mathfrak{B}_a = 58{,}000$, from Table XXIV., is $\eta = 20{\cdot}92$, and the eddy-current factor for $\mathfrak{B}_a = 58{,}000$, and $\delta = .020''$, from Table XXVII., is $\epsilon = .097$; hence the energy losses due to hysteresis and eddy currents, from (39) and (41), respectively:

$$w_h = 20{\cdot}92 \times 6{\cdot}67 \times 11 = 1\,535 \text{ watts.}$$

$$w_e = .097 \times (6{\cdot}67)^2 \times 11 = 47 \text{ ,,}$$

The total energy dissipation in the armature, by (42), is:

$$W_a = 6{,}350 + 1{,}535 + 47 = 7{,}932 \text{ watts.}$$

11. *Specific Energy Loss and Temperature Increase in Armature.*—From Table XXIX., the length of the heads of our armature will be:

$$l_h = .35 \times 28 + 2 \times .8 = 11\tfrac{1}{2}\text{in.}$$

The radiating surface, consequently, from (44):

$$O_a = (28 + 2 \times .8) \times \pi \times (38 + 1{\cdot}8 \times 11\tfrac{1}{2}) = 5{,}550 \text{ square inches.}$$

The pole area being about $30 \times \pi \times 38 \times .8 = 3{,}040$ square inches, the ratio of pole area to total radiating surface is $\frac{3{,}040}{5{,}550} = .55$; and since the peripheral velocity is 50ft. per second, we obtain from Table XXX. a specific temperature increase of $\tau_a = 45{\cdot}5$deg. C. The rise of armature temperature, therefore, will be, by formula (47):

$$t_a = 45{\cdot}5 \times \frac{7{,}932}{5{,}550} = 45{\cdot}5 \times 1{\cdot}43 = 65\text{deg. C.}$$

12 *Circumferential Current Density and Running Value of Armature.*—From (49) we obtain

$$\gamma = \frac{168 \times \frac{600}{2}}{28 \times \pi} = 572 \text{ amperes per inch of core circumference.}$$

This value is within the load limit given in Chapter 20; the output of the dynamos under consideration, 300 kilowatts, must, therefore, be within the limit of maximum safe output, which is really the case, for from (53) we obtain

$$W_{max} = 28^2 \times 38 \times .91 \times 30{,}000 \times 400 \times 10^{-6} = 325{,}000 \text{ watts}$$

The running value of the armature is found from (54):

$$\rho = 20{,}000 \times \frac{515 \times 600}{620 \times 30{,}000} = 332 \text{ watts per pound of armature conductor at } \mathfrak{B} = 20{,}000,$$

which is within the practical limits given in Table XXXIII.

II. *Dimensioning of Magnet Frame:* (1) *Total Flux Through Magnetic Circuit.*—From Table LII., the probable leakage-factor of a 300-kilowatt upright horseshoe-type machine is $\lambda = 1{\cdot}20$, and therefore the approximate total flux:

$$\Phi' = 1{\cdot}20 \times 46{,}000{,}000 = 55{,}200{,}000 \text{ webers} = 55{\cdot}2 \text{ megawebers.}$$

2. *Area of Magnet Frame.*—The cores and yoke being of wrought iron, the sectional area required, according to Table LIX., is:

$$A_m = \frac{55{,}200{,}000}{90{,}000} = 614 \text{ square inches.}$$

3. *The Magnet Cores.*—The cylindrical form of cross-section being chosen, the diameter of the magnets is:

$$d_m = \sqrt{614 \times \frac{4}{\pi}} = 28\text{in.}$$

* From the *Electrical World* (New York).

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The length is obtained from Table LXIV. by interpolation—viz.: $l_m = 35$in. Distance apart from Table LXVIII.: $c = 16$in.

4. *The Yoke.*—The width of the yoke, in the type chosen, is equal to the diameter of the cores; therefore, its height:

$$h_y = \frac{614}{28} = 22\text{in.}$$

The length of the yoke is given by the diameter of the cores and by their distance apart:

$$l_y = 2 \times 28 + 16 = 72\text{in.}$$

5. *The Pole-pieces.*—The bore of the field is found by adding the following items:

Diameter of armature core		= 28·000
Winding	$4 \times \cdot 322''$	= 1·288
Insulation and binding	$2 \times \frac{5}{32}''$	= ·312
Clearance (Table XLVIII.)	$2 \times \cdot 2''$	= ·4
Field bore	d_p	= 30·000in.

Pole distance, from Table XLVII.: $c_p = 5 \times (30 - 28) = 10$in.

In Table LXX. the remaining dimensions of the pole-pieces for the case in question, cast iron being employed, are given as follows:

Height of pole-pieces	$h_p = 30\frac{1}{2}$in.
Length " "	$l_p = 38$in.
Thickness in centre	= 15in.

6. *The Zinc Blocks.*—Table LIV. gives the height of zinc blocks for dynamos of 300 kilowatts capacity and with a 28in. drum armature as $h_z = 11$in.

Fig. 139 shows the field-magnet frame thus dimensioned.

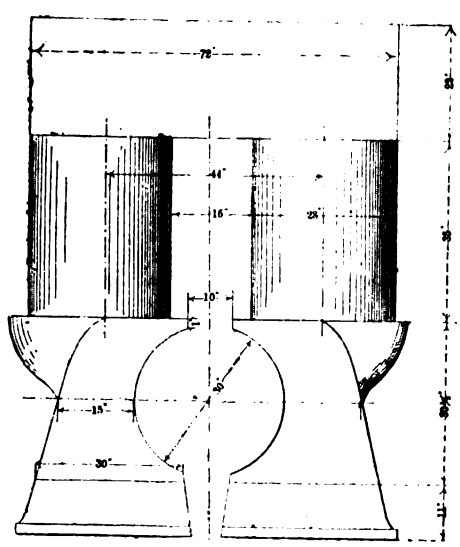


FIG. 139.

III. *Calculation of Magnetic Leakage.*—The permeance of the gap spaces, from (126), is:

$$P_1 = \frac{\frac{1}{4}\left(28 \times \pi + 30 \times \pi \times \frac{141}{180}\right) \times 38}{1{\cdot}30 \times (30 - 28)} = \frac{1{,}540}{2{\cdot}6} = 593.$$

The permeance across the magnet cores, from (129):

$$P_2 = \frac{28 \times \pi \times 35}{2 \times 16 + 1{\cdot}5 \times 28} = \frac{3{,}080}{74} = 41{\cdot}6.$$

Permeance across pole-pieces, by (114):

$$P_3 = \frac{\frac{1}{2} \times \left[38 \times \left(30 + \frac{30\frac{1}{2}}{2}\right) + 900^*\right]}{2 \times 11} + \frac{2 \times 38 \times 1}{10}$$
$$= 59{\cdot}6 + 7{\cdot}6 = 67{\cdot}2.$$

Permeance between pole-pieces and yoke, by (114) and (115):

$$P_4 = \frac{500\dagger}{35} + \frac{38 \times 30\frac{1}{2}}{2 \times 35 + (30\frac{1}{2} + 22)\frac{\pi}{2}} = 14{\cdot}3 + 7{\cdot}6 = 21{\cdot}9.$$

Actual leakage factor, from (110):

$$\lambda = \frac{593 + 41{\cdot}6 + 67{\cdot}2 + 21{\cdot}9}{593} = \frac{723{\cdot}7}{593} = 1{\cdot}22.$$

* Portion of bedplate opposite one pole-piece.

† Projecting area of pole-piece (=area, top of pole-piece—area of magnet core).

The actual total flux, consequently,

$\Phi' = 1{\cdot}22 \times 46{,}000{,}000 = 56{,}000{,}000$ webers
$= 56$ megawebers.

IV. *Calculation of Magnetising Force*: (1) *The Magnetic Circuit.*—The magnetic circuit of our machine consists of four different portions:

Air-Gaps:

Area: $A_g = \frac{1}{4}\left(28\pi + 30\pi \times \frac{141}{180}\right) \times 38 = 1{,}540$ square inches.

Length: $l_g = 1{\cdot}30 \times (30 - 28) = 2{\cdot}6$in.

Density: $\mathfrak{B} = \frac{46{,}000{,}000}{1{,}540} = 29{,}900$ lines per square inch.

Armature Core: Mean density (see above, I., 9): $\mathfrak{B}_a = 58{,}000$ lines per square inch. Specific magnetising force, from Table LXXI.:

$f(\mathfrak{B}_a) = 12{\cdot}2$ ampere-turns per inch.

Mean length of circuit in armature core, see Fig. 140:

$$l_{(a)} = 18\tfrac{1}{4} \times \pi \times \frac{109\frac{1}{2}\text{deg.}}{360\text{deg.}} + 9\tfrac{3}{4}' = 27\text{in.}$$

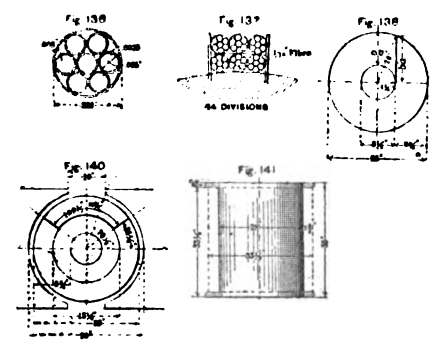
Wrought-Iron Part of Field Frame (Magnet Cores and Yoke):

Area: $A_w = 28^2 \times \frac{\pi}{4} = 616$ square inches.

Length: $l_w = 2 \times 35 + 22 + 44 = 136$in.

Density: $\mathfrak{B}_w = \frac{56{,}000{,}000}{616} = 91{,}000$ lines per square inch.

Specific magnetising force: $f(\mathfrak{B}_w) = 53{\cdot}8$ ampere-turns per inch.



Cast-Iron Part of Field Frame (Pole-Pieces): Least area (in centre): $15 \times 38 = 570$ square inches.

Corresponding maximum density:

$$\frac{56{,}000{,}000}{2 \times 570} = 49{,}200 \text{ webers per square inch.}$$

Greatest area (at pole face):

$$\frac{30 \times \pi}{2} \times 38 \times \frac{141\text{deg.}}{180} = 1{,}400 \text{ square inches.}$$

Corresponding minimum density:

$$\frac{46{,}000{,}000}{1{,}400} = 32{,}800 \text{ webers per square inch.}$$

Average density in cast iron:

$$\mathfrak{B}_c = \frac{49{,}200 + 32{,}800}{2} = 41{,}000 \text{ lines per square inch.}$$

Specific magnetising force: $f(\mathfrak{B}_c) = 93{\cdot}2$ ampere-turns per inch.

Mean length of circuit in pole-pieces: $l_c = 40$in.

2. *Magnetising Forces Required for the Various Portions of the Magnetic Circuit.*—M.M.F. required for gap spaces: $at_g = 0{\cdot}3133 \times \mathfrak{B} \times l_g = {\cdot}3133 \times 29{,}900 \times 2{\cdot}6 = 24{,}400$ ampere-turns.

M.M.F. required for armature core: $at_a = f(\mathfrak{B}_a) \times l_{(a)} = 12{\cdot}2 \times 27 = 330$ ampere-turns.

M.M.F. required for wrought-iron portion of frame: $at_w = f(\mathfrak{B}_w) \times l_w = 53{\cdot}8 \times 136 = 7{,}320$ ampere-turns.

M.M.F. required for cast-iron portion of frame: $at_c = f(\mathfrak{B}_c) \times l_c = 93{\cdot}2 \times 40 = 3{,}730$ ampere-turns.

M.M.F. required to compensate armature reactions:

$$at_r = (k) \times \frac{m \times C}{2} \times \frac{a}{180\text{deg.}} = 1{\cdot}5 \times \frac{84 \times 600}{2} \times \frac{19\frac{1}{2}}{180}$$
$$= 4{,}100 \text{ ampere-turns.}$$

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Total magnetising force required :

$AT = 24,400 + 330 + 7,320 + 3,700 + 4,100 = 39,880$ ampere-turns.

V. *Calculation of Magnet Winding.*—Magnet winding to be figured to give a temperature increase of $t_m = 20$deg. C. over the standard temperature of 15·5deg. C. Extra regulating resistance at normal load to be 10 per cent. of the magnet resistance.

Radiating surface of magnets, see Fig. 141.

$O_m = 2 \times (28 + 2 \times 2\frac{3}{4}^*) \times \pi (35 - 1\frac{1}{2}^\dagger) = 7,050$ square inches.

The conditions of heat radiation from an electromagnet are similar to those of an armature at rest, with pole-pieces removed; for these conditions, from Table XXX., the specific temperature increase of 75deg. C. for one watt of energy loss per square inch of radiating surface is derived.

The permissible energy loss in the magnet winding, therefore, is found from :

$$W_m = \frac{t_m}{75\text{deg.}} \times O_m = \frac{20\text{deg.}}{75\text{deg.}} \times 7,050 = 1,880 \text{ watts.}$$

The total energy absorbed in the entire shunt circuit (magnet resistance + extra resistance) is :

$$W'_m = 1{\cdot}1 \times 1,880 = 2,070 \text{ watts.}$$

Current flowing through shunt :

$$C_m = \frac{W'_m}{e} = \frac{2,070}{600} = 3{\cdot}46 \text{ amperes.}$$

Number of turns on magnets :

$$T = \frac{A\,T}{C_m} = \frac{39\,880}{3{\cdot}46} = 11,530 \text{ turns.}$$

The mean length of one turn being given by Fig. 141, the total length of the magnet wire is obtained from :

$$L_m = \frac{11,530 \times (28 + 2\frac{3}{4}) \times \pi}{12} = 93,000\text{ft.}$$

The total resistance of the shunt circuit, including the extra resistance, is :

$$r''_m = \frac{e}{C_m} = \frac{600}{3{\cdot}46} = 173{\cdot}5 \text{ ohms.}$$

The magnet resistance alone, therefore :

$$r'_m = \frac{173{\cdot}5}{1{\cdot}1} = 157{\cdot}5 \text{ ohms at } (15{\cdot}5\text{deg.} + 20\text{deg.})$$

or, $= 35{\cdot}5$deg. C.

$$r_m = r'_m \times \left(1 - \frac{t\,\text{deg}_m}{300}\right) = 157{\cdot}5 \times {\cdot}933 = 147 \text{ ohms at } 15{\cdot}5\text{deg. C.}$$

The specific resistance of the magnet wire fulfilling the above conditions is :

$$\frac{r_m}{L_m} = \frac{147}{93,000} = {\cdot}00158 \text{ ohm per foot at } 15{\cdot}5\text{deg. C.}$$

The nearest gauge wire is No. 12 B. & S., having a specific resistance of ·001581 ohm per foot; 93,000ft. of this wire will, therefore, give an actual magnet resistance of :

$$r_m = 93,000 \times {\cdot}001581 = 147{\cdot}1 \text{ ohms at } 15{\cdot}5\text{deg. C.}$$

The total weight of the magnet winding is :

$$lb_m = 147{\cdot}1 \times 12,503 = 1,840\text{lb. bare;}$$

or, $$lb'_m = 1{\cdot}028 \times 1{\cdot}840 = 1,890\text{lb. covered.}$$

The given machine is consequently to be wound with 945lb. of No. 12 B. & S. wire (·081″ + ·008″) per magnet.

The current density in the magnet wire is

$$\frac{6,530}{3{\cdot}46} = 1,890 \text{ C. M. per ampere.}$$

Electrical efficiency of machine :

$$\frac{W}{W + W_a + W_m} = \frac{300,000}{300,000 + 7,932 + 1,880} = {\cdot}968, \text{ or } 96{\cdot}8 \text{ per cent.}$$

If a temperature increase higher than $t_m = 20$deg. C. had been permitted in the field coils, more energy could be spent in exciting the magnets; the shunt current would, therefore, be correspondingly greater and the number of turns correspondingly smaller, resulting in a smaller weight of copper.

* Height of magnet-winding space, from Table LXIII.

† Allowance for core flanges.

EXPERIMENTS ON THE RELATION OF HYSTERESIS TO TEMPERATURE.*

BY FRANK A. LAWS AND HENRY E. WARREN.

This paper gives an account of some experiments to determine the effect of temperatures much above the normal on the dissipation of energy by hysteresis in a specimen of steel.

At the time of the beginning of this research, in February, 1894, there were no complete studies of this subject known to us. A casual reference is to be found in the *Proceedings* of the American Institute of Electrical Engineers, vol. vii., p. 325, 1890, by Prof. Harris J. Ryan. The tests there referred to were made on a cast-iron ring. The maximum temperature employed was 360deg. The details of the measurements are not given. A short paper by Dr. Wilhelm Kuntz appeared in the *Electrotechnische Zeitschrift*, vol. xiii., May 6, 1892. In this Dr. Kuntz showed that the hysteresis loss decreased with rise of temperature. A second paper by the same author appeared in the *Electrotechnische Zeitschrift*, vol. xv., April 5, 1894. The magnetometer method was used by Dr. Kuntz in this work. In this paper tests of several ferrous materials are given, as well as some on a specimen of nickel.

At the outset of this research it was decided that alternating currents should be used, and that the losses should be determined by a wattmeter, thus reducing the time required for observations to a minimum. The instrument which we designed and used we decided to call a watt-balance. Mr. A. E. Kennelly has given in the *Electrical Engineer*, December 21, 1892, a description of a "Differential Wattmeter." This instrument gives the difference of the mean values of two definite integrals representing the primary and secondary energy in a transformer—that is, the losses. The watt-balance measures the ratio of the mean values of two definite integrals. It can therefore be used to measure the efficiency of a converter, giving the result by a single reading.

The watt-balance consists of two electrodynamometer wattmeters one above the other. The movable coils are rigidly connected in our instrument by a spiral-wound paper tube, and consist of 100 turns of silk covered German-silver wire, No. 32 B. & S. gauge. The resistance, including leads, is 103 ohms; the diameter of coils 2cm. In series with the movable coils are two adjustable resistances, r_1 and r_2, as shown in Fig. 1. The stationary coils are arranged in pairs; each is 2·3cm. in mean radius, and contains 130 turns of No. 12 cotton-covered wire. They are movable along their axes, so that the factor of the instrument may be adjusted. The vertical distance between the two dynamometers is 30cm. The movable parts are suspended by a silk thread inside a narrow paper tube to prevent disturbance by air currents, and directive force is given by four spiral springs made of copper wire 0·005cm. in diameter. These springs serve as leading-in wires for the movable coils. The instrument is read by a telescope and scale.

In Fig. 1 is shown the scheme of connections for a hysteresis test. At the left the slide resistances for controlling the currents are shown. By the proper insertion of the connection, C, either a direct or an alternating current could be sent through the remainder of the apparatus, which in the main circuit consisted of an electrodynamometer, one pair of stationary coils, the specimen under test, a known resistance, R, of German-silver strip immersed in kerosene oil to keep it at a constant temperature, and the second pair of fixed coils. At one terminal of R a connection was made by means of a short piece of stout wire and a key, K; beyond the key the circuit branched, passing through the adjustable resistances, r_1 and r_2, the proper movable coils, and returning one lead to the external terminal of the specimen, and the other to the corre-

* Contributions from the Physical Laboratory of the Massachusetts Institute of Technology to the *Proceedings* of the American Academy.

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sponding terminal of R. The resistance r_1 was some hundreds of ohms, seldom falling below 300, and was more frequently in the neighbourhood of 1,000; r_2 was kept at a constant value, 976 ohms. The resistances, r_1 and r_2, were ordinary plug-boxes, and the assumption was made throughout the work that the resistances of circuits r_1 and r_2 were so high in comparison with their inductances that no correction factor need be applied to the indications of the watt-balance. It may be well to mention that the use of high resistances constructed in the usual way by double winding may lead to serious errors in alternating-current measurements on account of the capacity effects.

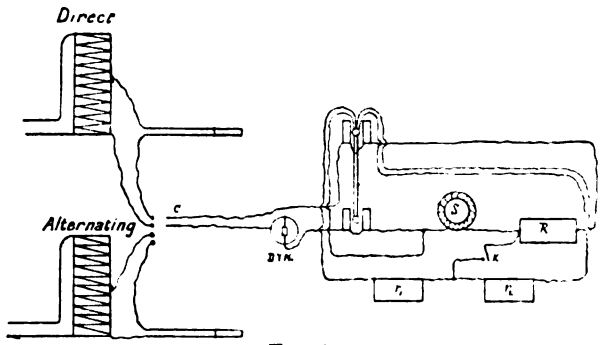

FIG. 1.

If the plug, C, be inserted so that a current flows in the apparatus, and no deflection is observed, then the factors of the upper and lower dynamometers are equal; if the key, K, is depressed, there will in general be a deflection, which may be reduced to zero by adjusting r_1, as a zero reading means that the average values of the products of the currents in the two coils of the upper and lower dynamometers are the same. It is known that the work in S bears the same ratio to the work in R that the total resistance in circuit r_1 does to the total resistance in circuit r_2 If the current is alternating, the work in S is of course divided between hysteresis and heating losses. No allowance has been thought necessary for the work done in the suspended coils. If W_S and W_R represent the work in the specimen and in R, then

$$W_S = W_R\left(\frac{r_1+103}{r_2+103}\right) = \frac{I^2R(r_1+103)}{r_2+103}.$$

I^2 is given by the electrodynamometer D Y N.

To correct for the heating loss in S, a direct current of any convenient magnitude is sent through the circuit, and a second balance, r_1^1, obtained:

$$R = 1{,}079 \text{ ohms}, r_2 = 976 \text{ ohms}; \text{ so } W_S = \frac{I^2}{1{,}000}(r_1 - r_1^1).$$

It will be seen that the watt-balance, as used in the present case, is a wattmeter with an electrodynamic control. The advantage derived from obtaining this control by shunting a portion of the main current is that any manipulation of the circuits does not disturb the equilibrium of the instrument, and that it renders it possible to use the instrument in a null instead of a compensation method.

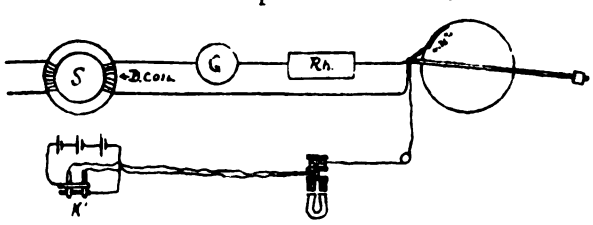

FIG. 2

As the hysteresis loss is a function of the maximum magnetisation, denoted by B, it was necessary to provide some means by which the maximum might be kept constant, and its value determined. The device sketched in Fig. 2 was used for this purpose. In addition to the magnetising coil, the specimen was provided with a winding of 24 turns, which was connected in series with an adjustable resistance of 874 ohms during the tests and a galvanometer of 126 ohms. Leads were carried to the dynamo-room, and terminated in brushes which rested on the edge of an ebonite disc 11in. in diameter fastened rigidly to the dynamo shaft; the brushes were carried by a radial arm, the motion of which is controlled by a small magneto-motor driven by three Leclanché cells. The motor was governed by a reversing key in the testing-room, about 100ft. away. The alternator used had 10 poles, thus making the length of a wave 72deg. A piece of brass, 36deg. or one-half a wave long, was set into the edge of the disc, and the whole carefully trued up. When the dynamo was in action the B current was closed once during a revolution, and for a time corresponding to one-half a wave length. The galvanometer then performs the operation—

$$\frac{2}{T}\int_{t^1}^{t^1+\frac{T}{2}} C\,dt$$

1,500 times a minute. The value of this integral will be a maximum when it extends over the time between + B and − B. By the use of the key, K^1, the brushes may be shifted, and the reading of the galvanometer brought to its greatest value. With the dynamo running at its normal speed a Leclanché cell, E.M.F. 1·4 volts, was inserted in the circuit; R h was 1,374 ohms, and the deflection 21·2 cm.; with brushes short-circuited and R h equal to 14,874 ohms the deflection was 21·8 cm., the ratio of deflection being ·972. If the brushes made perfect contact, and there was no self-induction effect, the ratio would be unity, the entire cycle of operation being performed in a time short compared with the period of the galvanometer. During the tests the reading with R h = 1,374 was frequently repeated in order that the brushes might be kept in as uniform a condition as possible.

Owing to the manner in which the specimen is constructed, the area included in the B winding is but partially occupied by the iron. In calculating the approximate values of B no allowance has been made for this, as the permeability is high in the cases where B has been determined. If observations were taken at temperatures where the permeability was very low, it would be necessary to apply a correction for this unoccupied area. The values of B were calculated by the formula—

$$B = \frac{E^1 R D}{20 A N n R^1 D^1}$$

D is the deflection corresponding to the value of B to be found; R is the resistance in circuit R h; N, the number of turns on B winding; n, the number of revolutions per second; A is the area of the iron included in the B windings; D^1 is the deflection of the galvanometer when an E.M.F. of magnitude E^1 and a resistance R^1 are inserted in the circuit R h, the dynamo turning at the normal rate.

(To be continued.)

SOME PRACTICAL HINTS IN DYNAMO DESIGN.*

BY GILBERT WILKES.

When the matter of this lecture first came up for consideration I thought I would discuss generally the results in relation to designing drawn from my shop experience. I had not, however, gone far when I realised that this subject would cover a number of lectures, so it was limited to refer to continuous-current machines for general purposes. Not only are alternating-current machines designed on very different lines from continuous-current dynamos, but that large and varied class of machines used for traction purposes, and represented principally by the street-car motor, is, I believe, an equally distinct class. The design of street-car motors brings in so many points that place in the background the rules for ordinary designing that the one is little guide to the other.

Street-car motor design is, or should be, more the result of reasoning, based on actual personal experience on a car and under it in the pit, than that of hours and days at a desk. The rules for shafts and bearings for stationary machines are of little use here, and some of the most successful street-car motors are machines of poor electrical design. One I recall has a magnetic leakage of 35 per cent. The real power for continuous work is never equal to the rating of a street-car motor, and the method of control has much to do with the average possible work obtainable without overheating. I have therefore limited my subject to stationary machines—generators and motors for standard work, with special reference to medium-sized machines—neither very large nor very small.

* From the *Bulletin* of the University of Wisconsin.

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The first thing to be considered is—and this really comes before the actual work of designing—What is absolutely necessary in any good dynamo? In order to compete with other machines on the market, a few points are absolutely essential. These points are to influence the design, but no trimming can be allowed upon them, and to them all considerations of economy, weight, size, and appearance must bend.

The first of these preliminary requisites is mechanical stability, and whether the type is to be the horseshoe or inverted horseshoe, bipolar or multipolar, iron-clad or Manchester, whether the armature is to be smooth or slotted, the same remarks will apply. Let not economy or a bearing of trimmer appearance dictate the use of a small shaft. This is a point in which electrical engineers are systematically criticised by their mechanical brethren. Dynamo shafts are too often on the wrong side of safety. This error is probably an heirloom to us from the time when the generation of electricity itself was so puzzling a conundrum that all other questions were relegated to the background.

I remember one of the first dynamos that I saw—about 11 or 12 years ago. The dynamo-room (which was on board ship, where every square foot is valuable) was large and contained a remarkable tangle of belting and jackshafts, which would be considered ridiculous to-day. The dynamo ran, however, and the lamps gave light, thus answering the most rigorous requirements of the time, until one evening the pulley was wrenched completely off with the end of the shaft. I once heard a complaint from the business side of a company against the large-sized shaft of a large new dynamo. The answer was, "Did you ever hear anyone complain in buying an engine that the shaft was too heavy?" The machine was a success, and the only comments afterwards made about the shaft (which was 5½in. for 150 kilowatts) were to the effect that it was according to common sense.

Let the shaft run in good solid bearings, supported on a solid base. Whether the machine is mounted on skids or the more expensive sub-base, give it a broad foothold. Do not let the weights overhang the extreme points of support like the balls on a balancing pole. The side pull of the belt with a high centre line of shaft will tend to tip the machine, and the changes in the pull due even to the undulations of the belt will cause a tremor in the machine. You may feel it with the hand, and think it a matter of no importance. But each tremor jars the brushes, and in weeks the effects may be visible on the commutator, while in months the foundation may be shaken to pieces. Let your work be such that when it is completed and accepted you have heard the last of it. The dynamo is here to stay. It is to-day as reliable as a high-grade engine, and not one-tenth of 1 per cent. as dangerous.

One does not have to look back many years to the time when each new plant was rather expected to turn in reports of burned-out armatures or fields, when a new street-railway plant might burn out armatures actually by the dozen. But now if an armature is lost in a generator, it is the cause of close enquiry. Not quite so good a record, however, can be shown by most companies in the matter of the armatures of street-car motors. A record of 10 per cent. of the armatures burned out on a new street-railway line in the first three months is not bad.

After the mechanical features comes absence of spark at the brushes. A dynamo minder has no patience with a machine that sparks, and his disgust is soon transmitted to his employers, so that the machine is in disfavour. It is worse than giving a dog a bad name. A large part of the electrical *personnel* is still migratory, and a machine's reputation travels fast.

It is not too much now to expect absolutely no sparking at the brushes under practically constant load, and none under a change either way of 50 per cent. of full load. In fact, the best machines will stand sudden changes from no load to full load, and *vice versâ*, without sparking. If you have ever watched a 20in. belt when opening and closing the snap switch which controls the full load of a 150-kilowatt generator, you will realise the enormous mechanical and electrical strains a good machine must be made to stand for exigencies really as severe as this not infrequently occur in the operation of railway plants. However, my remarks are not intended so much in relation to these larger machines as to the smaller sizes. There are few firms manufacturing dynamos of 150 kilowatts or greater capacity, and therefore the competition is not so severe, and greater freedom is allowed the designer of the large units.

In a visit to the first Edison central station in Pearl-street, New York, one could not look at the hot scored commutators, and see the evidence of excessive wearing, without being almost forced to the conclusion that the generation of electricity and the destruction of copper went hand-in-hand. But this was in the days of Edison's Jumbos—strange to say these first large generators were direct driven—while everyone now knows, in contrast, the beautiful Edison dynamos of later times. In fact, until the last few years, the history of the constant-pressure dynamo in this country is largely a record of Edison's great work. Now even his name does not appear on any dynamos that are on the market.

The commutator of a modern stationary machine will last for years, and often will run, with a proper arrangement for collecting the current, for more than a year without even being turned down.

The brushes and brush-holders must be simple, and should be preferably automatic in taking up wear. Opinion is divided as to the proper material for brushes, and the largest makers seem to prefer copper in some form for large-current machines. Carbon is, however, much easier on the commutator. Brushes of carbon and their brush-holders can be designed which will take off the current just as well as those of copper, and cost no more. The commutator, however, brings in an additional cost where carbon brushes are used.

Considerable prominence was given last year to a device for preventing the shifting of the neutral point by a special arrangement of the series field. The particular form of machine which I have seen illustrated was of what is commonly known as the continental type. I did not see the particular machine, but, from considerable experience with this type, I believe that the dynamo would, if properly designed, work equally sparkless when built as an ordinary machine. I have designed a full line of these machine from 5 to 45 kilowatts. The brushes of any member of the series may be rocked fully 30deg. on each side of the horizontal plane without any sign of sparking, and the lead never changes with the load.

All makers agree in setting about the same limits for heating. The armature is usually not allowed to go above the temperature of boiling water. Occasionally, in order to get more money for a given amount of iron and copper combined in a determined form, a company will increase the ratings of its machines, but loss of reputation and a few burned-out armatures usually have the effect of cooling their ardour and later—the machines. Owing to the effect of the large mass of the field, the temperature of the outside of the coils is never that of the hottest part of the wire, as can readily be seen by bridge measurements. It is, therefore, good practice to run the fields about 15deg. centigrade, as shown by the thermometer, cooler than the armatures. Many formulæ are given for determining the armatures and the fields for a given heating and output, and these often do not agree. But I fancy that much of the disagreement lies in the different forms of fields, different ends to the armatures, and different methods of heading up. Most of the formulæ for field heating take no account of the fact that there may be more cooling by conduction through the iron of the magnet cores than from true radiation. The only safe rule is to learn the constants for a particular type of machine by experiment and make your own empirical standards. Even the heating in different sizes of the same type will vary somewhat from the usual coefficients.

The last point to be considered before commencing upon the specific design of a machine is the bearings. The leading manufacturers use a ratio of length to diameter of bearing varying from 3 to 4½, the usual ratio being about the mean of these figures. The English seem to use shorter bearings than we, and, judging from recent articles in English publications, the self-oiling and self-aligning box is rather new with them. In this country a dynamo cannot go on the market as a high-grade machine without this very desirable feature.

Having thus outlined the considerations which hold good with any high-grade dynamo, we can consider the questions which must receive attention in the designing proper. The most important of these is economy of manufacture. Thirteen years ago it did not matter if the field cores of an Edison "Z" machine were not only twice as long as necessary, but, in fact, were the cause of a waste of material and efficiency, making the machine both cost too much and require too much power for a given output. At that time few people knew any better, and dynamo building in this country was carried on by only two or three small concerns. The importance of economy had not as yet been felt; machine work was lavished without question. Anything was done to make the dynamo work; then it was sold for a large enough price to cover all shortcomings in economy of manufacture. I had to do with an evidence of this lavishness in expense when an officer in the navy. An Edison "L" machine, a 250-lighter, was installed on board ship in 1882. It towered above me, and naturally had not its sea legs on. In order to keep it upright a heavy bronze brace, weighing from 200lb. to 300lb., was bolted to the keeper and to the ship's deck. There was evidently a determination to prevent any loose magnetism getting away by this route. Yet this needless waste in using bronze never excited remark. Matters are now in a very different condition. Every state—almost every town of over 100,000 inhabitants—has one or more smaller or larger manufacturers of electric machinery up to the size of 75 h.p. The business in these smaller machines is enormous, but the margins of profits are very close. There are probably a dozen different makers whose machines fill the preliminary requirements of a good dynamo. Several of these, with enough others to make about 10, are apt to meet in competition on every contract of considerable size. Large sums of money are invested in the different companies, and, with very perfect systems of com-

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mercial enquiry, the principal companies are alive to the opportunities of every contract. Every dollar on the selling price counts. Remember that magnet wire costing originally about 18 cents per pound costs double this before it leaves the shop on a completed machine. I will explain this large increase. Different shops have different methods of costing. In some, the cost of the actual amount of raw material required for the finished article is added to the sum obtained by placing a fixed charge per hour for each class of work and keeping account of the number of hours each operation requires. In other shops, to the cost of the raw material is added the actual cost of the labour of the men. To this is also added a proper proportion of the shop salaries and general shop expenses. In either case the result is usually known as the shop cost, and amounts to about the increase already mentioned.

The design of the dynamo must be so perfect in economy that when all these additions—running expenses of the shop, shop salaries, percentage for interest and depreciation of plant, percentage for offices, agents, and commissions, and, finally, the percentage for profit—have been made to the actual bare cost of the labour and material, the price must not exceed that of other reliable makers. Think of this, and you will appreciate how dimes in the original material mount up into dollars in the selling price, and an hour's labour at even 15 cents makes a large difference in the product.

There are several details of design and manufacture on which an hour might be spent exclusively, but I shall touch only briefly on the following: building up the armature core; armature winding; commutator construction; prevention of sparking; the relation of size of armature to output; and the relation of field loss to radiating surface. Each of these subjects is worthy of a separate lecture, and in these days, when a new armature insulator is advertised every month, one ought to be posted on the requisites of a good insulator for this purpose, to keep from being led astray by plausible agents.

Armature Core.—There are a great many different mechanical methods of building up the cores of armatures, varying not only for the drum, Gramme, and Pacinotti types, but also varying in each type. All are, however, built up of thin discs of sheet iron or mild steel, forced together between two substantial heads by means of hydraulic pressure or powerful screw presses, and held tight by through-bolts, nuts, and thread on the shaft, or shrunk collars on the shaft. I have used the last method with success in the case of drum armatures, but great care is necessary to obtain the best Norway iron for the collars to prevent their bursting when contracting on the shaft. There are three methods of preparing the plates for the laminations—first, by pasting paper on one side of each sheet, and then punching out the armature plates; second, by punching the plates from the sheets and separating them with loose sheets of tissue paper in building up the armature; third, by using no separator at all, and relying on the oxide formed in rolling to separate the plates sufficiently from metallic contact. This separation does not need to be of high resistance.

I regret that I cannot now state the difference in heating due to the different methods of construction, but I am now having armatures built up to determine this point. It is usual to turn armature cores and balance them before preparing them for the wire. The turning of course tends to bridge over the insulation between the discs, but it is necessary to make a good mechanical job.

The iron usually used is not less than 14 mils thick, the paper should be not more than one mil. Concerning the thickness of iron, many of the smaller concerns use taggers iron, which is not made in this country, but comes from England. It is only seven mils thick and costs, pound for pound, twice as much as good domestic iron 14 mils thick. The latter therefore commends itself if it is adapted to the purpose. To determine this point I made very thorough tests on 15-kilowatt armature cores built of each, with the result that the heating was with the thin discs 29deg. C. and with the thick 38·5deg. C., when run for three hours at their proper speed and field, the induction of which was 5,300 lines of force per square centimetre. This decided me in favour of the thick iron. There is one unknown factor in armature heating—eddy currents in the core—and this must be determined for each type of machine and kind of iron. A loss equal to that for the hysteresis is a usual figure.

In designing dynamos you will find that you cannot always control all of the quantities as you wish. Thus in the continental type, unless you wish to use very high speeds and have very little torque in the machines as motors, you must use large armatures, and this means low induction, as the fields are of cast iron.

Armature Winding.—Armature winding is like the "15" puzzle. When accustomed to the general plans, you can carry them in your head and will become fascinated with the new ideas that form themselves in intricate curves and cross connections. But fortunately or unfortunately for the inventor, there seems to be little new under the sun in this line, and one is very apt to find his pet scheme only a variation of one of the many diagrams in that little book, entitled "Ankerwicklungen der Gleichstrom Dynamomaschinen," by E. Arnold. It is useless to touch on this very broad subject. I will simply say that the old Siemens-Hefner-Alteneck winding has had its day and is succeeded by a number of symmetrical windings. The Gramme ring is disappearing for four-pole machines and being succeeded by the Pacinotti drum, wound preferably with symmetrical replaceable coils. This substitution, weight for weight and dollar for dollar, increases the output of a machine 15 to 20 per cent. or more, depending upon the size and design.

Commutator Construction.—The commutator is the most vital part of the machine, and too much attention cannot be paid to it. There are dozens of different-shaped bars and modifications of the general way of holding them in place. Great variety of opinion exists as to the amount of insulation to be used between the bars. I have found the thickness of insulation between the bars the sole cause of destructive sparking in a line of machines which otherwise worked well and were cured of this by thinning the mica. What sense is there in putting as much mica between the bars, where there is small difference of potential, as there is between the bars and hub, where there may be at least half the voltage of the machine? I have found in my experience that thinner mica between the bars than is usually used gives better results. The proper amount varies with the number of segments and kind of brushes. The best practice is now unanimous in requiring mica between the bars and at the ends of the bars. This does not refer to the special direct-connected generators, whose conductors also serve as commutator segments. The size of bars and diameter of commutator vary greatly with the kind of brush. On account of economy of operation, automatic adjustment, and small amount of attention required, I prefer the carbon brush for all purposes, except, of course, for special machines either of very high voltage or very great current (as for electrical deposition). I have spent much work and study on the subject of brushes, for carbon brushes have some serious faults, though they are ideal in the matter of wear of commutator, small cost, and the small attention they require. The high specific resistance of the material causes heating in the brushes, and, by conduction, in the commutator. To overcome this, I have tried several plans, such as plugging the carbon with bunches of fine wires; depositing a heavy coat of copper around parts of a brush and then soldering these segments together; building up a brush of two thin plates of carbon with a sheet of copper gauze between and soldering a connection to this gauze. The last promised well, but in the course of a few months the commutators showed cutting, and the plan was abandoned for a simple carbon brush with a flexible lead soldered to the back. Carbon brushes were also tried encased in brass sheaths, but these arced to the brush-holders and stuck. Other plans which I have tried are encasing copper gauze in babbitt, and also making the whole brush of a block of babbitt feed radially. One small machine fitted in this way has been running two years without showing wear either on the brushes or the commutator, but I have not seen the plan succeed with larger machines. The following data give an idea of the comparative size of commutators using copper and carbon brushes. The Edison 45-kilowatt bipolar machine has 52 segments, a brush bearing surface 5 19-32in. long and 6 13-16in. diameter; the same sized machine of the continental type designed by me, using carbon brushes, has 34 segments, with a bearing surface 8½in. long and 9½in. in diameter, or there is nearly twice as much copper in the one using carbon brushes. This is, however, an extreme case, as this is the largest-sized machine that I should recommend building of this type. The brushes are thick and are apt not to bear over their entire surface, and yet it is difficult to sub-divide them. Of course, going into the multipolar type, the brushes for low voltages and heavy current can be made thinner and more numerous. I shall compare these two 45-kilowatt machines again later.

Prevention of Sparking.—The prevention of sparking is such a large subject that it is a pity to touch upon it at all, as it can only be imperfectly discussed. There have recently appeared on the subject a number of papers in the English electrical journals which are worth reading.

Sparking may come from careless attendance, overload, error in design (such as thickness of commutator insulation which is not based on calculation), insufficient number of commutator segments, insufficient carrying capacity of segments, brushes covering too many or two few bars, and instability of the neutral point. I leave out of the above machines of positively bad electrical design that have no neutral point. It used to be considered as necessary for steady, sparkless running under wide variations of load that the field magnets should be saturated and operated well above the knee of the curve of the iron of which they are built. In this I do not agree, and where light weight is no object, I prefer to run lower on the curve—at about the knee—as the magnetism at this point is more unstable, and I think the iron can reply more quickly to changes of magnetisation, and therefore keep the voltage of the machine more constant under rapid variations.

Granting that the machine is not badly designed, the three

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principal conditions for obtaining a steady neutral point, and therefore the sparkless condition, are: the proper number of commutator segments, a proper ratio between the ampere-turns on the fields and of the distorting coils on the armature, and a proper ratio between the total magnetising force required and that used in overcoming the reluctance of the gap. The first two conditions are inter-dependent. The first is more the result of reasoning from experience with dynamos—not only in the shop and testing-room, but in practice with machines of different designs—than from calculation. The other two are dependent upon the type, and one must make his own empirical formulas from the data of the first tests.

It is the third condition—the proper ratio between the magnetising force required to overcome the gap and the total magnetising force—that shows us why it is so much easier to build a sparkless small dynamo than a large one, for 80 or 90 per cent. of the total magnetising force is necessary to overcome the high gap resistance. The area of cross-section of the gap is not only small, but owing to there being several layers of wire on the armature the length is relatively greater. This also points out one reason why small machines are relatively much more expensive, because relatively so much more copper is necessary on the fields. Thus, a 1-h.p. machine costs about one-twentieth of a 50-h.p., and a 3-h.p. about one-seventh of a 50-h.p. machine.

Going back to the 45-kilowatt continental machine, of which I have already spoken. It is at the head of a list of machines of that type. We would therefore expect its field coils to weigh proportionately less than any others of the series, and, if so, that it should be nearer the sparking limit; also, that the complete machine should weigh proportionately less than the other members of the series and cost proportionately less. All of these points are true. The weight of wire on the field is only equal to that on the similar 20-kilowatt machine. Its speed is 800 revolutions at 110 volts as a motor, and when run at about 35 per cent. above this by weakening the field, the machine is unbalanced, and there appears that peculiarly disagreeable snapping at the brushes. Yet the machine runs at its proper speed with absolutely no lead and no sparking at the brushes. The machine does weigh and cost proportionately less than the other members of the series. Its frame is made entirely of one iron casting, and yet the weight of wire on the armature is practically the same as that on the armature of the 45-kilowatt Edison machine above referred to; the weight of the wire on the fields is less, and the total weights are: Edison, 6,800lb.; continental, 7,625lb. This is a very remarkable result when it is remembered that the Edison machine is of wrought iron, and that a considerable expense is necessary in building it to machine and fit the parts of the field circuit. The two machines run at the same speed. Wrought iron does not necessarily make the lightest machine, nor cast iron the cheapest. The design must be adapted to the material to be used.

The Relation of Size of Armature to Output, and the Relation of Field Loss to Radiating Surface.—Concerning the relation of size of armatures to output, different rules are given by different people, and, in fact, not only will the watts per square inch allowable differ for Gramme rings, Pacinotti and drum armatures, but different armatures of the same type but different size will give varying results. A larger ratio of watts per square inch can be allowed for armatures having a single layer, than for those having several layers of wire. This also holds true for field coils. The wide variation that exists may be illustrated by the fact that Kapp states that in field coils the watts per square inch of radiating surface may be taken between one and four. This would be rather an unsatisfactory basis on which to begin designing. I have found Esson's figures good for a first approximation.

As regards the present field for continuous-current designing, the popular gaze is for the present in the direction of polyphase power-transmission apparatus, so that the time is peculiarly suited for quiet study and advance in continuous-current work. It is not necessary that the idea should be entirely novel. Many of the best plans have failed owing to not being worked out properly. See the toothed armature. Four years ago it was regarded as a thing of the past, and was simply remembered as Pacinotti's pioneer attempt. To-day it has returned in an improved form and displaced everything else for large machines and small slow-speed machines.

Something must be done to cheapen the manufacture of small machines, say, from 5 h.p. down, and my remarks may contain a hint as to one way of accomplishing this. Remember that the gap reluctance in small machines is much greater than is necessary from reasons of good running. Is it not possible to use iron wire for these small machinos both on the armatures and fields? I feel sure it is. The fine wire used on these machines is very expensive, costing more than twice as much per pound as for the larger sizes. I have already built fan motors, even for 500 volts, using iron wire exclusively, and the machines were not larger than the usual run of fan motors of equal capacity. I hope soon to try iron wire on small machines of somewhat greater capacity.

One last remark in relation to experimental machines. Let them be roughly made, for they will be very expensive anyhow. An experimental machine should never be begun until the improvement sought for is well fixed in the mind, and all the calculations are made showing just what the machine ought to do, and every detail drawn out to scale. Drawings are slow, tedious, and expensive, but you can change them, and cannot materially alter the final product when it appears in copper, brass, and iron.

ELECTRIC LIGHTING PROVISIONAL ORDERS.

There has been issued a copy of memorandum stating the nature of the proposals contained in the provisional orders included in the Electric Lighting Provisional Orders (No. 5) Bill. These are as follow:

Bootle Corporation Electric Lighting Order, 1895.—The undertakers under this order are the Corporation of Bootle. The area of supply is the borough of Bootle. The order contains provisions that the Corporation shall lay down mains in certain specified streets within a period of two years, and it provides for the supply of electrical energy in the remainder of the area on certain specified conditions. The order also contains provisions—

(1) For the approval by the Board of Trade of the system upon which energy is to be supplied, and the issue by them of regulations for securing the safety of the public and for ensuring a proper and sufficient supply of energy; (2) for the execution of the necessary works and the breaking up of streets, etc., and the alteration of pipes, etc., under streets; (3) for regulating the manner in which energy is to be charged for and fixing the maximum price to be charged; (4) for the appointment, remuneration, and duties of electric inspectors, and the testing of electric lines and other works, and for holding enquiries by the Board of Trade as to the causes of accidents affecting the public safety; (5) for the supply, use, certifying, inspection, etc., of meters; (6) for the application of moneys received by the undertakers in respect of the undertaking; (7) for the transfer to any company or person of the powers, duties, and liabilities of the Corporation under the order by means of a deed to be approved by the Board of Trade, upon such terms, and subject to such exceptions and modifications (if any), and for such period as may be specified therein; (8) for the revocation of the order under certain circumstances.

New Windsor Corporation Electric Lighting Order, 1895.—The undertakers are the Corporation of New Windsor. The area of supply is the borough of New Windsor and the Eton urban district. The order contains provisions similar to those referred to in the case of the previous order.

Prescot Electric Lighting Order, 1895.—The undertakers are the British Insulated Wire Company, Limited. The area of supply is the urban district of Prescot. The order contains provisions (1) that the undertakers shall lay down mains in certain specified streets within a period of two years, and it provides for the supply of electrical energy in the remainder of the area on certain specified conditions; (2) for the deposit of a certain sum as a guarantee that the works shall be completed; (3) for the audit of the accounts of the undertaking; (4) for the approval by the Board of Trade of the system upon which energy is to be supplied, and the issue by them of regulations for securing the safety of the public, and for ensuring a proper and sufficient supply of energy; (5) for the execution of the necessary works, and the breaking up of streets, etc., and the alteration of pipes, etc., under streets; (6) for regulating the manner in which energy is to be charged for, and fixing the maximum price to be charged; (7) for the appointment, remuneration, and duties of electric inspectors, and the testing of electric lines and other works, and for holding enquiries by the Board of Trade as to the causes of accidents affecting the public safety; (8) for the supply, use, certifying, inspection, etc., of meters; (9) for the revocation of the order under certain circumstances. The order also provides for the revocation of the Prescot Electric Lighting License, 1894.

Salisbury Electric Lighting Order, 1895.—The undertakers are the Salisbury Electric Light and Supply Company, Limited. The area of supply is the city of Salisbury. The order contains similar provisions to those referred to, and numbered (1) to (9) in the case of the Prescot Electric Lighting Order, 1895, above mentioned. The order also provides for the revocation of the Salisbury Electric Lighting License, 1894.

Southampton Electric Lighting Order, 1895.—The undertakers are the Southampton Electric Light and Power Company, Limited. The area of supply is the county borough of Southampton. The order provides that the undertakers shall lay down mains and furnish a supply of electrical energy throughout the area of supply on certain specified conditions. The order also contains provisions similar to those referred to and numbered

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(3) to (9) in the case of the Prescot Electric Lighting Order, 1895, above mentioned. The order provides for the purchase of the undertaking by the local authority within 12 months from the commencement of the order upon terms settled by the order. The order also provides for the revocation of the Southampton Electric Lighting License, 1890.

Windermere and District Electric Lighting Order, 1895.—The undertakers are the Windermere and District Electricity Supply Company, Limited. The area of supply is the urban districts of Grasmere, Bowness, and Windermere, a portion of the district of the South Westmorland Rural District Council, the urban districts of Ulverston and Grange, and a portion of the district of the Ulverston Rural District Council. The order contains similar provisions to those referred to and numbered (1) to (9) in the case of the Prescot Electric Lighting Order, 1895, above mentioned. The order also provides for the purchase by the local authorities of the distributing mains and distributing plant belonging to the undertakers in the respective districts after the expiration of 10 years from the commencement of the order by agreement.

The Electric Lighting Provisional Order (No. 6) Bill refers to the—

Liverpool Electric Lighting Order, 1895.—The undertakers under this order are the Liverpool Electric Supply Company, Limited. The area of supply is a portion of the city of Liverpool and of the Local Government district of Toxteth Park. The order contains a provision that it shall not have any force or effect unless the boundaries of the city of Liverpool are, by a provisional order made by the Local Government Board and confirmed by Parliament during the present session, extended so as to include the urban district of Toxteth Park. The order also contains provisions (1) that the undertakers shall lay down mains in certain specified streets within a period of one year, and it provides for the supply of electrical energy in the remainder of the area on certain specified conditions; (2) for the audit of the accounts of the undertaking; (3) for the approval by the Board of Trade of the system upon which energy is to be supplied, and the issue by them of regulations for securing the safety of the public, and for ensuring a proper and sufficient supply of energy; (4) for the execution of the necessary works and the breaking up of streets, etc., and the alteration of pipes, etc., under streets; (5) for regulating the manner in which energy is to be charged for, and fixing the maximum price to be charged; (6) for the appointment, remuneration, and duties of electric inspectors, and the testing of electric lines and other works, and for holding enquiries by the Board of Trade as to the causes of accidents affecting the public safety; (7) for the supply, use, certifying, inspection, etc., of meters; (8) for the revocation of the order under certain circumstances. The order authorises the Corporation of Liverpool to purchase the undertaking, after due notice, on June 30, 1900, or on June 30 in any subsequent year, or, by agreement, in any earlier year, on certain terms specified in the order. The order also provides for the revocation of the Liverpool Electric Lighting Orders, 1891 and 1892, and the Toxteth Park Electric Lighting Order, 1891.

LEGAL INTELLIGENCE.

MARSHALL v. SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.

In the debenture holders' action of Marshall *v.* the South Staffordshire Tramways Company, Limited, Mr. Jelf, Q.C. (with him Mr. Willis Bund), on behalf of the plaintiff, on Monday appealed to the Master of the Rolls and Lords Justices Kay and Smith from an order of Mr. Justice Day in Chambers staying proceedings against the company, for whom Mr. Bramwell Davis, Q.C., appeared to resist the appeal. It transpired in the course of a long conversational explanation of the case that a receiver had been appointed in a Chancery action for and on behalf of all the debenture-holders of the company.

The Master of the Rolls: And this one debenture-holder wants to pursue a common law action on his own account?

Mr. Jelf said he would be frank, and say no doubt that was so. The fact was plaintiff wanted to accelerate the happy dispatch of the company, and to know what his fate was to be as to any possible assets.

Lord Justice Kay: But will any court allow him to bring two actions for the same thing? He has obtained a judgment as a debenture-holder in the action brought on behalf of the debenture-holders; and what more do you want or can you say you are entitled to?

Mr. Jelf: As one of the other debenture-holders, we want to prosecute our claim.

Lord Justice Kay: You being included in this very judgment?

Mr. Jelf assented, but submitted the plaintiff had a right, like any other creditor, to come in and say that his claim should be enforced without waiting for the winding-up under the other proceedings.

Lord Justice Kay: I can only say I never saw this device tried before.

Mr. Jelf assured the Court that he was innocent of having devised it.

The Master of the Rolls: Perhaps you are also innocent of having advised it.

Mr. Jelf said he would rather not go into that question, but submitted he was entitled, in some way or another, to bring the matter to a head, and was not bound under the Chancery action to wait for all the delay involved in the bringing up of accounts, but might take the ordinary course open to him in an undisputed claim, and upon it to bring about a winding-up of the company.

Lord Justice Kay: If you are right, every debenture-holder might bring a separate action, notwithstanding a judgment granted for and on behalf of all the debenture-holders.

The Master of the Rolls: Your first action you bring as and for all the debenture-holders, and ask for a receiver; and on the second you proceed also as a debenture-holder, and ask for judgment out and out for yourself. We had better hear if your junior can make out a better case than that, involving endless actions.

Mr. Willis Bund accordingly submitted that there were questions on the construction of the debenture to be tried,

Which, observed **Lord Justice Kay**, you can raise and have settled in the Chancery action quite as well as in a common-law action.

At the close of the learned counsel's submissions the **Master of the Rolls** (without calling on counsel for the company) said the sufficient answer to the application was that plaintiff had already brought an action against the company and got judgment under it, and a second action could not be brought and ought not to be allowed, and the appeal would therefore be dismissed.

Lord Justice Kay, in expressing his concurrence in that view, said that all and every question possible of being raised on the debenture could be as well settled in the Chancery Court as under a common law action, as this was. He agreed that the learned judge below was quite right in staying the action.

Lord Justice Smith assenting, the appeal was dismissed accordingly, with costs.

COMPANIES' MEETINGS.

UNITED RIVER PLATE TELEPHONE COMPANY.

The ninth annual general meeting of this Company was held on Tuesday at Winchester House, Mr. J. Irving Courtenay occupying the chair.

The Chairman, in moving the adoption of the report and accounts, congratulated the shareholders on the improved position of the Company, and that the expectations he set forth at the meeting last year had been, to a fair extent, realised, so that the directors felt justified in recommending a dividend of 3 per cent. on the ordinary share capital. The advices from the Company's representatives in the River Plate pointed, in spite of frequent fluctuations, to a distinct general improvement in business there. The collections for the year under review—£149,262—were the largest the Company had ever had for a similar period, and, taking everything into consideration, could not but be deemed to be most encouraging. The number of subscribers had increased from 5,363 to 5,798 on March 31 last, and the increase continued.

The motion was carried unanimously.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bristol.—The Committee of Visitors of the Bristol Lunatic Asylum, Fishponds, invite tenders by July 15 for supply and fixing the necessary wires, lamps, etc., for lighting the asylum by electricity.

Dortmund.—The Stadtgemeinde invite tenders by August 14 for the construction of a large electric central station. Conditions and plans may be obtained for one mark from Das Magistratsamt, Dortmund, Germany.

Hapton.—Tenders are required for the electric lighting of the village of Hapton from September 1 to April 30, 1896. Number of lights required will be about 50. Tenders to be sent to the chairman of the Hapton Parish Council before July 15.

Blackburn.—The Corporation of Blackburn invite tenders for the wiring of the town hall. Copies of the specification may be obtained from the engineer, Mr. E. M. Lacey, of 19, Old Queen-street, S.W., on payment of £1. 1s., which will be refunded on return of same accompanied by a *bonâ fide* tender. Plans may be seen at the office of the town clerk, or the engineer, from whom any further information can be obtained. Tenders must be sent in by to-morrow (13th inst.).

Wellington.—The Wellington (Salop) Urban District Council require tenders for lighting the urban area or lighting district with gas or electricity. The said district comprises about six miles of streets and roads, and is at present lighted by about 200 ordinary gas lamps and three of Sugg's patent treble lights. Further particulars may be obtained from the surveyor, Mr. G. J. Monson, C.E., 45, Walker-street, Wellington. Tenders, endorsed "Tender for Lighting," must be sent to the clerk, Urban Council, Wellington, Salop, by 12 noon on July 15.

London, W.—The Hammersmith Vestry invite tenders for complete schemes for public and private lighting, and for the supply

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of motor power in that portion of the parish of Hammersmith described in the provisional order as the compulsory area. Memoranda of instructions, with a map of the district, may be obtained from Mr. H. Mair, surveyor to the Vestry, on or after July 10, 1895, between the hours of nine and five, Saturdays nine and one, on payment of a deposit of £10, which will be returned to persons sending in a *bonâ fide* tender. Tenders are to be delivered at the meeting of the Vestry, at the Vestry Hall, at 6.30 p.m. on September 4.

London, W.C.—The Metropolitan Asylums Board invite tenders for the supply and running of mains in the grounds and for the wiring of buildings now in course of erection at the North-Western Fever Hospital, Haverstock Hill. Conditions of contract and specification, prepared by Prof. Ayrton, may be purchased, price 10s., at the offices of the Board, Norfolk House, Norfolk-street, Strand, W.C. Deposited plans can be seen at the hospital any weekday between 11 a.m. and 4 p.m on production of the specification. Sealed tenders prepared in accordance with the printed instructions, are to be delivered at the offices of the Board by 11 a.m. on July 18.

Datchet (Berks.).—Tenders are invited for lighting the village of Datchet, for the Barker's Bridge House Trust, during October to March, with oil, gas, or electricity. The present number of lamps is 33. Any further number hereafter to be erected in the parish to be included at the rate quoted. Tenders may be for lighting partly by one method and partly by another. The lamps must be lighted at sunset and kept alight until 1 30 a.m. The contractor must supply all requirements and fittings for the lamps (the present posts and lamps being available as far as they will serve) for the lighting as above specified, and must keep the lamps clean and in good repair to the satisfaction of the trustees. Tenders must be sent to the trustees of Barker's Bridge House Trust, care of Mr. H. L. Prior, The Priory, Datchet, by 6 p.m. on 20th inst.

Derby.—The Electric Lighting Committee of the Corporation invite tenders for the builder's work in the boiler seatings for three new boilers and in new coal-store, etc., and accessories, at the central station. Plans may be seen on application to Messrs Bramwell and Harris, engineers, 5, Great George-street, Westminster, S.W., or to the town clerk, Town Hall, Derby, from either of whom may be obtained, on deposit of £2. 2s., to be returned on receipt of a bona fide tender, a printed copy of the specification, form of tender, and bill of quantities. Tenders, on the prescribed form, must be delivered, with the specification attached and unaltered, enclosed in a sealed envelope, endorsed "Electric Lighting—Tender for Buildings," and addressed to Mr. H. F. Gadsby, town clerk, at the Town Hall, Derby, by 12 noon on 22nd inst.

Brighton.—The Brighton Town Council invite tenders for the supply and erection at their electricity works, North-road, of evaporative brass-tube surface condensers, electrically-driven air-pumps, exhaust and condenser piping; also for the supply and erection at the electricity works, North-road, of steam and feed piping, cast-iron storage tanks, feed-water filters, electrically-driven feed pumps, circulation economiser, coal-elevator, and sundries. Specifications can be obtained on application at the town clerk's office, Town Hall, Brighton, on payment of one guinea, which will be refunded on return of the specification, accompanied by a *bonâ fide* tender. Sealed tenders, addressed to Mr. Francis J. Tillstone, town clerk, endorsed "Tender for Condensers, etc.," or "Tender for Steam Piping, etc.," must be sent to the town clerk's office, Town Hall, Brighton, by 10 a.m. on July 15.

Valletta (Malta).—Sealed tenders will be received at the office of the Receiver-General and Director of Contracts, Valetta, or at that of the Crown Agents for the Colonies, Downing-street, London, until 11 a.m. on August 1, for the supply of materials in connection with the installation of the electric light in the civil and war department buildings in Malta. The materials are comprised under four headings—viz, (1) cables and wires, (2) tools, etc., (3) fittings, fixtures, etc., (4) sundries. Printed forms of tender and of the specifications and conditions may be obtained on application at the above office, Valletta, or at the office of the Crown Agents for the Colonies, Downing-street, London. Each tender must contain the name of the surety whom the tenderer intends to propose for securing the performance of the contract and the payment of the penalties therein established. The surety to be a person residing in the island. No notice shall be taken of any tender not accompanied by a deposit, to be made in the office of the Receiver-General and the Director of Contracts, Valletta, or in that of the Crown Agents in London, of a sum of £5 sterling, to be forfeited to the Government should the party tendering, or his surety, in the event of the tender being accepted, fail to appear for signing the contract within three days from the day of the notice given to them to that effect. If the tenderer is not resident in Malta, his tender must contain the name of an agent residing in the island, to whom, in the same tender, power must be given to represent the tenderer in the contract. Any tenders which may be delivered at the Crown Agents' office must be in sealed packets addressed to the "Director of Contracts, Malta—Tender for Materials for Electric Lighting," under cover addressed to the Crown Agents for the Colonies.

Globe Telegraph and Trust Company.—A further distribution of 3s. 5d. per share is announced on the ordinary capital, leaving about £1,200 to be carried forward.

BUSINESS NOTES.

Great Northern Telegraph Company.—For the month of June the receipts were £25,200.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,969.

Durban.—The Capetown correspondent of the *Times* telegraphs that Durban is to be lighted by electricity.

Capetown and Suburban Electric Lighting Syndicate.—The payment is announced of a dividend of 7 per cent.

Stafford.—The Town Council have decided to extend the electric lighting cables along Tipping-street and as far as the new Baptist Chapel on Lichfield road.

City and South London Railway.—The returns for the week ending July 7 were £915, compared with £879 for the corresponding period of 1894, being an increase of £36

Removal.—The offices and works of the Nalder and Harrison Construction Syndicate, Limited, have been transferred to Trafalgar Works, Bow Common-lane, London, E.

Agency.—Mr. G. Straus, 130, Queen Victoria-street, E.C., informs us that he has been appointed sole agent for the United Kingdom and colonies by Messrs. Schiff, Jordan, and Co, of Vienna.

Liverpool District Lighting Company, Limited.—This Company has been registered, with a capital of £2,000, to carry on the business of an electric supply and gasworks company in all its branches.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 7th inst. amounted to £1,250, as compared with £917 in the corresponding week of last year, being an increase of £333.

Bourne Bros. and Co., Limited.—This Company has been registered, with a capital of £2,000, to adopt a certain agreement and to deal in and with indiarubber, guttapercha, and gums of every description.

Dundee.—At a meeting of the Gas Committee of the Town Council, Sir James Low and ex-Bailies Doig and M'Kinnon were appointed visitors to the gasworks and electric lighting station—ex-Bailie Doig convener.

Standard Electro-Galvanising Company, Limited. — This Company has been registered, with a capital of £4 000 in £1 shares, to carry on business as manufacturers and galvanisers of iron, steel, and other metals, or metal articles.

Bagnor (Wales)—A meeting of the City Council has taken place, at which Mr. Thomas Lewis said that the report of Mr. Medhurst, the electrical engineer appointed to assist the Council in electric lighting matters, was expected in a few days.

Chelsea Electricity Supply Company.—The directors of the Chelsea Electricity Supply Company, Limited, have declared an interim dividend on the 6 per cent. preference shares at the rate of 6 per cent. per annum for the half-year ending June 30.

Buxton.—The Urban District Council have held a meeting, at which a discussion took place as to what was being done by the Electric Lighting Committee, and Mr. Lawson expressed surprise at the scheme dying out after so much had been said about it.

Bury.—At a meeting of the Electric Lighting Committee of the Town Council it was resolved unanimously, after a report from the borough engineer, that the Council be recommended to defer the appointment of an electrical engineer until further enquiries have been made

Pinson and Evans, Limited.—This Company has been registered, with a capital of £20,000, to acquire as a going concern the business of furnishing ironmongers, ironfounders, and galvanisers, etc., as now carried on by Pinson and Evans, Wolverhampton, and to develop and extend the same.

Private Bill Legislation.—Mr. Mellor's Committee on Unopposed Bills has passed provisional orders authorising the London United Tramways to construct additional lines at Hammersmith and Acton, and empowering the Corporation of Windsor to undertake the electric lighting of Windsor and Eton.

Direct United States Cable Company.—A final dividend of 2s. per share, free of income tax is declared, payable on and after 31st inst., making, with the interim dividends already paid, 2 per cent. for the year ended June 30 last, and, after placing £7,000 to reserve fund, carrying forward a balance of £1,410.

Crosby.—The Urban District Council have held a meeting, at which communications were read from two electric lighting companies giving notice of their intention to apply in the next session of Parliament for provisional orders, giving them authority to supply the electric light within the Council's district.

Tonbridge.—The District Council have held a meeting, at which the Guildford Electricity Supply Company intimated their intention to apply to the Board of Trade for an order to supply electricity in the district, and the Council decided to deal with this as they had done a previous notice by the Holloway Company.

Sevenoaks.—The Urban District Council have received a letter from the Guildford Electric Supply Company, Limited, of Great George-street, Westminster, giving notice of their intention to apply for a provisional order to supply electricity for private and public purposes within the area of the Sevenoaks Urban District Council.

Wells.—The Town Council have held a meeting, at which a letter was read from Messrs. Davies and Roach regretting that they were unable to return the electric lighting contract signed

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by Mr. Dixon Browne, and suggesting the appointment of another electrician. The letter was referred to a committee of the whole Council.

Lewisham.—The District Board have held a meeting at which the Capital and Counties Electricity Supply Company, Limited, gave notice of their intention to apply to the Board of Trade for a provisional order to electrically supply consumers in the area of the Board's jurisdiction. This communication was formally received.

New Mains.—The London County Council have sanctioned the laying of mains by the Metropolitan Electric Supply Company in Little and Great Wild streets, Kemble-street, Russell-street, Wellington-street, Exeter-street, and part of the Strand. The work is necessitated by the recent fire at the company's generating station in Sardinia-street.

Bexhill.—The Urban Council have held a meeting, at which a letter was received from the Bexhill Water and Gas Company, asking that, in the event of the company undertaking to supply the town with electric light, the Council would acquiesce in their action. On the motion of Mr. S. Smith, the letter was referred to the Highways and Lighting Company.

Eastern Extension Telegraph Company.—Notice is given that the interest on the Eastern Extension Telegraph Company's 4 per cent. mortgage debenture stock for the half-year ending July 31 inst. will be paid by warrant on August 1. The 4 per cent. mortgage debenture stock register will be closed from the 27th to the 31st inst., both days inclusive.

Snaefell Electric Railway.—The Snaefell electric railway, one of the most enterprising works ever undertaken in Manxland, is rapidly approaching completion, and will be ready for opening when the rush of visitors comes a few weeks hence The railway opens out magnificent mountain scenery, and goes to the summit of Snaefell, the highest mountain in the Isle of Man.

Bradford.—The adoption of the minutes of the Gas and Electricity Supply Committee was at the last meeting of the Town Council moved by Mr. W. C. Dixon (chairman), and seconded by Mr. J. Kay (deputy-chairman). It appeared that arrangements had been made that an entirely fresh test of the oil-gas process of Dr. Dvorkovitz should be carried out. The minutes were adopted.

Hastings.—A meeting of the Urban Council has been held at which the clerk reported that he had received a letter from the Bexhill Water and Gas Company asking whether the Council would give them their support, if in the future they were to supply the town with electric light. On the proposition of Councillor S. Smith, the letter was referred to the Highways and Lighting Committee for consideration.

Chiswick.—The District Council have held a meeting at which the clerk read a letter from Messrs. Bourne and Grant agreeing to erect a shaft at the electric works station to be used as a dust destructor, in accordance with the suggestion of the Council, in the event of the Council agreeing to pay £750 towards the cost of the shaft and supply the steam for the use of the destructor. The matter was referred to a sub-committee

Ambleside.—A meeting of the District Council has been held, at which a letter was read from Mr. Moore with reference to the electric light. Colonel Rhodes was of opinion that the Council should oppose any outside movement on the sole ground that as soon as the Council had obtained the gas and water works it might then think it worth while to have its own electric works. Mr. Hunter seconded this, and it was referred to the Council.

Appointment Vacant.—The Birmingham Corporation require the services of an engineer fully competent to take entire charge of the electric light and power installation in the new school, Suffolk-street. Salary £2. 10s. per week. Applications, stating age, qualifications, and past experience, and accompanied by copies of not more than three recent testimonials, must be sent to Mr. Geo. Mellor, secretary, offices of the school, Paradise-street, Birmingham, on or before 13th inst.

Aberystwith.—The Town Council have held a meeting, at which the Public Lights Committee presented their report, which recommended that the surveyor should be instructed to have the lamps removed from the pillars on the Marine-parade, that an additional lamp should be placed on the Penparke-road, and that the report of Mr. A. H. Preece in regard to the electric lighting of the town should be adopted. After discussion, it was decided that the two recommendations in question should be referred back to the Public Lights Committee.

Ilfracombe.—A letter has been received from the electric light and power company by the Urban District Council stating their intention to apply for a provisional order to supply the town. Messrs. Baker and Co., parliamentary agents, wrote to advise the Council to apply for an order themselves At the meeting of the Council Mr. Walters said it would be wise for that body to apply, as the gas should be supplemented by electricity. It was decided that the whole question of lighting should be considered at a special meeting of the Council.

Cheltenham.—A meeting of the Town Council has been held, at which Alderman Norman brought up the minutes of the Electric Lighting Committee. He pointed out that the outlay was only between £800 and £900 in excess of the estimate, and that the difference, about 5 per cent., was very small as compared with the experience of some other towns. In addition, many things not originally contemplated were included in the expenditure. The machinery in use was working in the most satisfactory manner. Mr. Margrett thought the overseers had acted very fairly in assessing the undertaking at £400.

Eastbourne.—At the last meeting of the Town Council the minutes of the Lighting and General Purposes Committee stated that the town clerk reported that he had requested the Eastbourne Electric Light Company to make a reduction from their accounts with respect to electric lighting, and a letter was read from the secretary stating that his company were willing, as from the 30th inst., to make a reduction of 1d. per Board of Trade unit in the lighting supplied to the Town Hall and bandstand. It was resolved that the best thanks of the committee should be tendered to the company for such reduction. The minutes were confirmed.

Blackpool.—The Town Council have held a meeting, at which the report of the Electric Lighting and Tramways Committee showed that it had been resolved that a sub-committee, consisting of the Mayor, the chairman (Councillor Pearson), Alderman Buckley, and Councillors Heap and Smith, should be desired to consider Mr. Hammond's report of June 17 on the present position of the Corporation's electricity works and submit recommendations to the committee thereon, and that until a further extension of the Corporation's electricity works was made the committee felt unable to accede to new applications for supply of electrical energy.

Liverpool.—The Special Lighting Committee of the Liverpool Corporation have adopted a resolution that the Council be recommended to consider, and, if thought expedient, to approve of the intention to make application to the Board of Trade by the Mayor, aldermen, and citizens of the city of Liverpool, acting by the said Council of the said city, and being the local authority of the said city, for the purposes of the Electric Lighting Acts, 1882 and 1888, for a provisional order to supply electricity for public and private purposes, under the provisions of the said Acts, within the area of the city of Liverpool, as the same may exist at the time of granting the said order.

Capetown.—An interview between the representative of a weekly newspaper and an ex-mayor and well-known merchant of Capetown throws a new and not altogether satisfactory light upon the policy of requiring that the origin of all imported manufactures shall be declared. It would appear that German and American manufactures are supplanting our own productions in the markets of South Africa. This is said to be specially noticeable in hardwares, it being stated that Cape Colony storekeepers are importing enormous quantities of German goods, and that even the electric lighting machinery for Capetown was made in Germany and erected by German workmen.

National Telephone Company.—The directors of the National Telephone Company, Limited, have resolved, subject to final audit, to recommend a dividend for the half-year ending June 30 at the rate of 6 per cent. per annum, less income tax, on the amounts paid up on the first and second preference shares; at the rate of 5 per cent., less tax, on the amounts paid up on the third preference shares; and at the rate of 5 per cent., free of tax, on the amounts paid up on the ordinary shares. The sum of £35,000 is carried to reserve, and about £3,000 goes forward. The transfer books in respect of the preference and ordinary shares will be closed from 13th to 26th inst., both days inclusive.

Hampstead.—The Vestry have held a meeting, at which the Lighting Committee recommended that an electric lighting main for supply to consumers be laid down from the West End-lane extension along Inglewood-road to the corner of Holmdale-road, at an estimated cost of £86; that three smaller high-pressure feeders be substituted for the one large feeder ordered for the High-road, Kilburn, extension, at an additional cost of £271; that two smaller high-pressure feeders be substituted for the one large feeder ordered for the West End-lane extension, at an additional cost of £76; and that the necessary alterations be made in the panels of the switchboard at the central station, at an estimated cost of £15. The report was adopted.

Acton.—It was reported at the last meeting of the District Council that a letter had been received from the secretary of the Capital and Counties Electricity Supply Company, stating that it was intended to make application on or before December 21 next, by memorial to the Board of Trade, in pursuance of the Electric Lighting Acts 1882-1888, for a provisional order, to be confirmed in the ensuing session of Parliament, authorising the said Capital and Counties Electricity Supply Company to supply electricity for public and private purposes within the area of the jurisdiction of the Urban District Council of Acton. A letter had also been received from Messrs. Limbrey and Co., the solicitors to the company, to the same effect. It was remarked that at the proper time the Council would be prepared to oppose the grant of the provisional order, and Mr. Eydmann added that if the company got the order it would not be of much use to them.

Electricity in Mines.—At the annual general meeting of the Pigg's Peak Development Company, Limited, Mr. G. T. Rait, the chairman of the company, said that though they had the utmost confidence in Mr. Dicey as manager, they felt that in matters relating to the laying out and development of the property, such as the question of the use of electrical power for the working of the mill, they ought to have the best possible advice, and they had therefore appointed Mr. Knobel, who was well known on the Rand, as consulting engineer to advise with the manager as to the laying out of the mine. Mr. Knobel, after going over the property, had already made a report, and with regard to the fitting up of the electrical power the company would be guided in a large measure by what he said. The policy of the directors certainly was to work the Pigg's Peak property. They had had several assays of the ore made, and the average result showed 19dwt. and some odd grains to the ton. On the economical treatment of that ore, therefore, it all depended whether a profit could or could not be

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made. They must get the contract for the supply of electrical power on as advantageous terms as possible.

Douglas Electric Tramway—The arbitration proceedings of the Douglas and Laxey Electric Tramway Company took place at Douglas on Thursday last week before Messrs. Jas. Cowell, Corlett, and Robert Cain, arbitrators appointed by the Lieutenant-Governor to decide in any disputes arising in the acquirement by the company of land for the completion of their tramway. The question at issue was the price to be paid by the company to Mr. Hall, landlord of the Commercial Hotel, Laxey, for 725 yards of land opposite to his hotel, required by the company for their terminus at Laxey. Mr. T. Kneen appeared for Mr. Hall, and Mr. C. B. Nelson and F. Browne for the company. The land had been estimated by Mr. T. Wainwright, valuer, Liverpool, and others, on behalf of Mr. Hall, to be worth £2 a square yard, free of restriction; whilst others, on behalf of the company, said the value of the land, free of restriction, was not more than 15s. a square yard. A compromise was come to, by the terms of which the electric tramway company agreed to pay Mr. Hall £250 for the land, pay all costs of both sides, and restrict themselves not to erect any refreshment-room or hotel on the land in question.

Brighton.—The Town Council have received a communication from the Local Government Board with their sanction to the Council borrowing the sum of £43,650 for the purposes of electric lighting, and £2,500 for the purposes of public lighting, and the Council have referred the letter to the Finance Committee, with power to take the necessary steps to obtain the money. At their meeting on June 17, the Lighting Committee approved the action of the town clerk in requesting the gas company to continue the lighting of Marine-parade, etc., until September 30 next, the notice given to discontinue such lighting expiring on June 24, and the Corporation not being yet ready to light these streets with electricity. The committee again considered the letter from Councillor Halliwell, with reference to the lighting of Lewes-road, and suggesting that some of the Sugg's lanterns now in use on the Marine-parade should be removed there. It was resolved that the lanterns in Lewes-road be fitted with burners to consume 6ft. of gas per hour each, instead of 5ft. as at present. On the motion of Councillor Stafford, the proceedings of this committee were agreed to at the last meeting of the Town Council.

Sheffield.—A meeting of the Town Council has been held, at which Mr. Duncan Gilmour said that he noticed that the electric light company had laid their mains along Fulwood-road from Broomhill to Ranmore, and had disturbed the asphalte on the south side of the road to a width of about 14in. He also noticed that the whole length of the asphalte causeway about 6ft. wide on the south side had been, or was in course of being, removed and renewed. He wanted to know who was paying for this, what proportion were the ratepayers paying, and what would be the cost of the whole work chargeable to the ratepayers? The Mayor replied to the first question, the electric light company; to the second, "nothing;" and to the third, according to what other work might be done in connection with the paths. In moving the minutes of the Highway and Sewerage Committee later, the Mayor remarked that he might inform Mr. Gilmour that there was an arrangement by which the electric light company paid a certain amount of the cost of the footpath which he had mentioned. This amount covered the whole of the cost of asphalting, but not any extra cost incurred in the matter of kerbstones which the committee might consider prudent to have done.

Sale.—The Urban District Council have held a meeting, at which a letter was read from the secretary of the Altrincham Electric Supply Company, dated June 28, saying he was requested by his directors to notify that it was their intention to apply to the Board of Trade for a provisional order to supply electricity to the district, and asking for the sanction of the Council. Considerable discussion ensued as to allowing any outside authority to come in to supply electricity, and ultimately the matter was referred to the Parliamentary Committee. The Secretary also wished to know if the committee would allow him to appear before them to be heard, and to tender advice at any meeting that might be held. To this Mr. Wainwright said it might be a waste of the gentleman's time to be present, as the committee might wish to adopt the principle to supply electricity themselves to the township. Mr. Lloyd thought if the secretary was heard he might say something they could go upon, and so get ideas they might work out. Mr. Wells said he would be very chary indeed in granting powers to any company at the present time and so tie their hands. Mr. Critchley did not understand that the committee would have any power to grant anything.

Kingswood (Bristol).—The District Council have held a meeting at which a letter was read from Mr. E. Caspar, who had had an interview with the chairman and the clerk respecting Parfitt's patent and extra lighting. The document suggested that the Council should purchase the plant, and the conditions of extensions mentioned were: the additional power for public and private lighting would be that, beyond the power required for lighting, there should be power supplied for sale to small and large manufacturers. The letter further asked for particulars of the proposed extension of lighting. The Chairman said he could not admit that Mr. Caspar had been told by him that the Council entertained the purchase of the system. Mr. Wilshire said that they had not yet had the light that they had previously arranged for. Mr. Bridges was of opinion that their authority was to call upon the firm to supply the light they needed without entertaining the purchase of the system. The Chairman mentioned that if they ever did entertain the purchase of the light, he should certainly advocate the wires being put underground. They were not quite satisfied with the way in which their streets were lighted at present. It seemed to him that their best plan was to go in for additional lighting without thinking of purchasing the installation. It was then resolved that a list of the extra area to be lighted should be got out and forwarded to Mr. Caspar.

Dover.—The Town Council have held a meeting, at which the minutes of the committee appointed to consider the question of the quantity of light to be supplied in the Connaught Hall reported and recommended a certain number of lights which should be turned on and no extra charge made to the hiring of the hall. The cost would be 5s. 6d per hour. If the full number of lamps was required, a charge of 5s an hour should be made. Alderman Pepper carefully explained the report, and stated that about half the lights would be used. The additional cost over gas would be 3s. an hour. Councillor Ayres moved that the report be adopted. Councillor Burkett seconded. Alderman Peake said that Alderman Pepper had informed him that the extra cost over gas would be 5s., and taking that as correct would make the average cost per night 15s. Alderman Peake said that he did not think the ratepayers would approve of £112 being thrown away to the electric light company. Alderman Pepper said that if a gentleman got up and first made a statement which was incorrect, and then did a rule-of-three sum on an incorrect basis, there was no wonder he would get something startling. There were 134 lamps at ½d. each per hour, which was 5s., or 3s. 1d. extra. Alderman Peake: Then it is £70 a year more. The recommendation of the committee was carried. It was decided to make a connection with the mains at a cost of £7. 3s.

Tunbridge Wells.—Councillor Ryder asked at the last meeting of the Town Council when the electric light would be turned on. The Mayor explained there had been a delay with the machinery, some of which had to go back. Councillor Putland asked what was the salary of the electrical engineer, and why he had to give a guarantee. Councillor Burton said that but for the delay the arc lamps would have been lighted a week before the Council meeting. The Town Clerk pointed out that all officers had to give guarantees; the salary was £250. Alderman Delves asked the probable revenue from the expenditure of £12,000 on extending the mains. Councillor Wilmott asked if there would be no public demonstration to open the electric lighting. Councillor Wood said the committee felt that any public opening should take place in the Town Hall, and the light was now being installed there. They hoped to arrange some ceremony by September, but meanwhile the light in the streets would be turned on soon as possible. In reply to Mr. Delves he would not be drawn into prophecy, but from the number of applications for the light coming in he looked for a good return. It was decided to appoint Mr. H P. Boot, of Dublin, as electrical engineer. The town clerk was instructed to communicate with Messrs. Kelsey as to one of their tenants lighting his premises by electricity, and the engineer to make arrangements for the lighting of the arc lamps in the streets as soon as possible.

Monmouth.—Pursuant to a request by the Corporation to borrow £19,000 for the purpose of carrying out a combined scheme for sewage and its disposal, and the installation of electric light for public and private use in the borough, Colonel W. M. Ducat, R.E, Local Government Board inspector, has held a public enquiry. Mr. Ram represented the Corporation. The machinery for generating electric energy and pumping sewage will be fixed on the River Monnow, water being the motive power, and a stand-by steam engine to be kept for use in case of floods. The only opposition was a petition, signed by about 100 ratepayers, praying that the loan be not granted for electric lighting. The objectors were represented by Mr. Corner, Hereford. The engineers are Messrs Bramwell and Harris, and C. N. Lailey, London. In the course of the enquiry, which lasted about five hours, it was shown that by lighting the public lamps by electricity a considerable saving to the rates would be effected, and this, added to the probable sale of electric light for private use, would bring the cost of repayment of the loan from 1s. 2d. in the pound down to 6¼d. in the pound. No witnesses were called in support of the petition, and Mr. Ram commented on the number of names of directors and shareholders in the gas company appearing therein. At the conclusion of the enquiry, Mr. Ram asked the inspector to recommend the longest time possible for repayment of the loan.

Worcester.—The Town Council have held a meeting, at which the Deputy-Mayor moved the adoption of a reduced scale of charges for supply of current, for motive power, and for the hire of motors. Mr. Williamson said that in order to make the water power pay it was necessary to get a day load, a night load being already assured. They wanted to see the water power used during the daytime, and every horse-power they could get employed meant so much profit. Many people who used little power would find it more economical to use the current than to lay down a gas or steam engine, and if they could get 100 h.p. per day employed, that would pay the whole of the interest on the capital. It ought not to be difficult to get 100 h.p. taken up, and they might do a great deal in a year or two. Mr. Chaplin seconded. The Sheriff remarked that the electricity business seemed to be a constant source of surprises. Had they already reached the limit of the water power and of night consumption? Mr. Williamson replied in the negative, saying that although they had 12,000 lamps on, as was originally contemplated, they were not all burning. The Sheriff asked if it was the fact that the power was not sufficient for the waterworks pump and the lamps to be used together. Mr. W. Caldicott explained that the electricity was employed at the waterworks when it was not required for other purposes. Alderman Higgs supported the resolution,

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hoping that the power would be taken up, so that the scheme would result in profit rather than continue a burden on the ratepayers. Alderman Day advocated it as an auxiliary to their income. The resolution was carried.

Llanelly.—The surveyor's report upon tenders for electric lighting having been read at a meeting of the Borough Council, instructions were given to call a meeting of the Estate Committee to consider the same. The clerk read the following letter received from the London solicitors of Messrs. J. C. Howell, Limited, Llanelly: "To the Urban District Council of Llanelly.—On behalf of Messrs. J. C. Howell, Limited, of 24, Queen Victoria-street, in the city of London, and of Llanelly, in the county of Carmarthen, electric lighting contractors, we beg to give notice that it is their intention to apply during the parliamentary session of 1895-6 for a provisional order, under the Electric Lighting Acts 1882 and 1888, granting to the applicants statutory powers under the said Acts within the said urban district of Llanelly." The Chairman suggested that the matter be referred to the Property and Estate Committee Replying to questions, the Clerk said it was necessary that such a notice should be given to the Council, in order that they might lodge any protest against the order being granted if that course was found advisable. It was not certain as to what they would decide with regard to their own order for electrically lighting the town. Mr. D. W. Rees, in reporting to the Council, said that the committee had not gone fully into the question, but hoped to be able to present a report at the next meeting of the Council. The letter was then referred to the committee for further consideration. It was also reported that the question of placing the new town hall in telephonic communication with the old market stores was under consideration, and the architect was instructed to obtain further tenders for the same.

Derry.—A meeting of the Lighting Committee of the Corporation has been held, at which the Mayor presided, and there were also present Alderman Johnston, Councillors Hastings, Thompson, M'Kane, Brown, Boal, M'Cully, and Turner. Mr. Stafford read the minutes of last meeting. Councillor Hastings protested against the resolution proposed by Alderman Pollock, and seconded by Councillor Donnell, "that Mr. Christie be directed to give an estimate of the cost of the private lighting of the city by electricity." This had been carried in his absence, and he protested against it. If the Corporation and Alderman Pollock and Councillor Donnell thought he was not competent to be the chairman of the Lighting Committee, let them move that he be dismissed He challenged the man who wrote the resolution behind his back to justify it He moved that the resolution be expunged from the minutes He believed the committee passed it goaded on by Mr. Pollock and Mr. Donnell and he would not stand it. The Mayor said the matter could be brought up at the Council meeting. Councillor Hastings went into the matter of the accounts with Messrs. Siemens Bros., and said he was not satisfied with them, and would like time to consider them. Mr. Algeo entered into an explanation of the items, which seemed to satisfy Councillor Hastings. Councillor Thompson put some questions to Mr. Algeo on the electric lighting account. Mr. Algeo said the Corporation would be about £1,600 short. Councillor Hastings, referring to an item in the account with Messrs. Siemens Bros. about the use of gas, said he thought the Corporation should not press the matter about the gas. Mr. Algeo said that Messrs. Siemens Bros. had given the Corporation the cost of opening the roads and streets.

Cork.—Notices of their intention to apply for a provisional order to supply electricity within the city of Cork were read at the last meeting of the Corporation from Messrs. Hanrahan and Co., solicitors, on behalf of the Cork Gas Consumers' Company; Mr. R. A. Atkins, on behalf of the Cork Electric Light and Power Company, Limited; and from Mr. Edward Felton, on behalf of the Electricity Supply Company of Ireland, Limited. Alderman Julian enquired if they could do anything there. The Town Clerk said the matter should be referred to a committee and a special meeting held. Alderman Julian then proposed that a special meeting be convened for the purpose of considering the applications that had been made. The Town Clerk pointed out that there was an Electric Lighting Committee in existence. Mr. Dwyer asked if there were any of its members yet alive. The Mayor said he was one of them Mr. Barrett said he was another. He would oppose the gas company and he would oppose the new company also. He had the greatest respect for them all but he had more respect for the citizens of Cork, whose property was in question. Sir John Scott said he was one of the promoters of the new company, and he could assure them that the company would take every reasonable precaution to preserve the interests of the citizens After some further discussion, the matter was referred to the Electric Lighting Committee, composed of the following 14 members of the Corporation, who were connected with neither the new electric lighting company nor the gas company: the Mayor; Aldermen Crean, Creedon, Hungerford, Walsh, and Sheehan; Councillors Barry, Cronin, O'Donnell, Lucey, Farrington, Bogan, Franklin, and Kinmonth, with a request to report on the question of lighting the city by electricity generally.

Weybridge.—The Urban District Council have held a meeting, at which the Highway and Lighting Committee recommended that the contract for the public lighting should be allowed to run out. They further suggested that the clerk write to the Weybridge Electric Lighting Company stating that the Council would not require them to submit a contract for lighting. Mr. Bilney thought no definite steps should be taken until a meeting of the ratepayers had been held. There was now little more than two months before the present contract would expire, and he considered the Council was adopting the eminently dangerous policy of drifting. The question of public lighting was one which it was eminently fitting should be discussed by the ratepayers. He moved that no definite steps should be taken by the Council as to the future lighting of the village, until a public meeting shall have been held. Dr. Powell seconded. Mr. Ward thought the Council should be put into a position of knowing the exact value of the stock before they went before the ratepayers. The Chairman agreed, but remarked that he thought the resolution was a little premature. They had no idea in their heads as to what they were going to do. Mr. Bilney said he wanted the full facts placed before the Council before the public meeting was held. Mr. Reed said many of the ratepayers were anxious for a public meeting to be held on the question. Mr. Bilney thought the Council should have expert opinion on the matter. Mr. Chambers moved, as an amendment, that if the Highway Committee, after consideration, thought it desirable, a public meeting should be called to consider the future lighting of Weybridge. Mr. Rowland seconded, and the amendment, on being put, was carried. It was also resolved to appoint a small committee, and to employ an engineer, as suggested by Mr. Bilney. The committee consisted of Messrs. Chambers, Ward, Bilney, Jarvis, and Dr. Powell.

Amazon Telegraph Company, Limited.—This Company has been constituted, with a capital of £250,000 in £10 shares, to connect by cable the city of Manors, capital of Amazonas State and chief emporium of the Brazilian rubber trade with Para, the capital of Para State at the mouth of the Amazon. There will be, according to the prospectus, intermediate stations or branch lines at various places in the two states, and at Para the cable will join the land lines of the Brazilian Government, and the Western and Brazilian Telegraph Company's cables, connecting with the rest of Brazil and the Argentine Republic, will be placed in communication with Europe and the telegraph system generally by the cables of the Brazilian Submarine Telegraph Company. A concession has been granted by the Brazilian Federal Government including the following privileges: exclusive cable rights in the River Amazon for 30 years in the zone comprised between Para and Amazonas States; an annual subsidy in gold during the first 20 years of concession of £17,125; all favours granted to similar Brazilian enterprises and permission to enter into agreements with the Para and Amazonas Governments to establish other branch cables. The system will revert to the Federal Government at the end of 30 years, and the Government have also power to purchase after 10 years at a price based on the value of the works and the profits of the previous five years. The cables, which are to be about 1,365 miles in extent, are to be laid by March, 1896. Figures are given of the trade of the Amazon Valley and Para, and statistics of the telegraphic traffic, and the proportion due to the trade of the Amazonas and Para States, should be, it is estimated, 3,000,000 words. But calculating on telegraphic traffic to the amount of the traffic of 1894 of the city of Para alone the directors anticipate a gross revenue, together with subsidy, of £53,375, sufficient, after providing for working expenses, amortisation fund to redeem capital, and reserve, to pay over 10 per cent. on the capital. A large increase on these figures is, however, expected. The list closed on Wednesday.

Kingstown (Dublin).—A special meeting of the Kingstown Town Commissioners has been held, at which Mr. A. S. Findlater, presided. Mr. Clifton Robinson, C.E., and Mr. R. K. Clay, solicitor, were present. The meeting was held for the purpose of consulting with Mr. Robinson in reference to matters in dispute between the Kingstown Commissioners and the electrical tramway company in reference to the proposed double line through George's-street. Mr. Robinson (by permission of the meeting) made a statement, setting forth the views of his company on the merits of a double and single tram line in crowded places. He referred to the conditions under which it had been arranged with the Commissioners that a double line should be laid through George's-street, which conditions had not been imposed on them by the other townships. He pointed out that under the agreement to lay a double line, the tramway company would have to pave the entire street, but the company felt that it would be the only way to satisfactorily work the system. He pointed out that the narrower and the more congested the traffic might be, the more reason there would be for a double line. They proposed laying some cross-over lines which would obviate obstructions. If a single line was laid the Commissioners would find that they would never be free from obstructions, and then they would not be in a position to rectify their mistake. The company had entered into contracts for the double line, and time was also a great consideration with them just now. The rolling-stock was ready for delivery, and it would equal anything of the kind in the world. The cars would cost £800 each. Mr. Clay having been heard, Mr. Atwool moved a resolution approving of the double line, and calling on the company to proceed with the work in accordance with their parliamentary powers. Mr. Wallace seconded the motion. Mr. T. W. Robinson moved, and Mr. Moran seconded, an amendment to the effect that the line should be single from St. Michael's Hospital to Clarendon Park, West. The amendment was lost by 11 votes to 6. The original motion was adopted by the same division.

Barnet.—A meeting of the Urban District Council has been held, at which the clerk reported that he had attended at the Board of Trade office with reference to the provisional order for electric lighting. He was informed that the order would be further extended provided the Council satisfied the Board that they were doing something in the matter. Mr. Baughen asked if the order ran for another 12 months. The clerk replied that it did, Father Bampfield proposed that a special committee should

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be appointed, consisting of not more than four members, to go into the question of lighting and the water supply, and to report to the Council once a quarter. He spoke of the great importance of the question of lighting the district with the electric light, and suggested that the special committee in reporting from time to time should inform the Council of those towns where the electric light had been placed and had proved a success, and those towns where it had been placed and proved a failure. He was in favour of the appointment of a committee of four, because he did not believe in large committees. Mr. Rogers seconded the motion. He said he felt that the General Purposes Committee could not give the necessary time to these particular subjects. Mr. James expressed himself surprised at the motion. He said that Father Bampfield knew what the General Purposes Committee had done at their recent meetings with regard to the subject of electric lighting. If they started cutting down the number of a committee they might as well cut down the lot. He saw no reason for making such a reduction in the numbers. Mr. Baughen said he could hardly go with the mover of the proposition. Large committees had always been appointed in order that a quorum might be the more easily ensured. Mr. Parsloe observed that he was amused at some of the arguments in favour of the proposition. It would seem that there was some fear that they were going to rush the electric light. Personally he was not at all inclined to do so. He saw no necessity for the appointment of this committee. Father Bampfield replied on the discussion, and pointed out that the General Purposes Committee already constituted the majority of the Council, and that therefore it really constituted the governing body of the town. He thought the Council had not exactly taken hold of what he intended in the proposition. It was rather a surprise to him to hear complaints of the amount of time required of the members They must be prepared to give up their time. He had suggested that a committee of four should consider the matter of electric lighting, more especially since the matter required a good deal of reading and study. It would, indeed, be unfortunate, he thought, if they could not obtain four men who would undertake the study of this matter. He felt compelled to renew his proposition, which he hoped would be carried. The chairman reminded Father Bampfield that the General Purposes Committee could appoint a sub-committee to consider any particular matter. On being put to the vote four members voted for the resolution and five against it.

Birkenhead.—At the monthly meeting of the Town Council Alderman Deakin moved the proceedings of the Finance Committee, and referred to the acceptance of the tender by Messrs. Holme and Green, Liverpool, for the erection of the central electrical generating station in Bentinck-street for £4,440. Mr. Shoolbred, the engineer, had recommended tenders—which had been accepted—for the engines, dynamos, etc., to be delivered at certain times, and it was necessary to have a building ready to house them when delivered. The tender of Messrs. Holme and Green was considerably below the others, and the work was to be finished in six months However, some mistake had arisen owing to one of the sub-contractors having omitted a whole set of items amounting to £378. A special meeting of the committee was called, and it was seen that the mistake was a *bonâ fide* one, and that even with the addition the tender was still £80 below the others. Mr. Snape moved that the recommendation to alter the tender should be referred back. Alderman Walker seconded, and suggested an adjournment for a week Alderman Bloor protested against the Council voting on the sum of £4,440, and then it being taken as referring to £4,818. It was most irregular, and the latter sum was really not before the Council. Mr. Byrne thought the contract should be given to Mr. J. Shaw, a Birkenhead contractor, as his amount was only £82 higher. Alderman Deakin said the committee had taken the utmost precautions that there should be no knowledge of what the other tenders were. It was a *bonâ fide* mistake, and the committee thought it desirable to amend the tender. After further discussion, the amendment was carried by 20 votes to 16 At Wednesday's meeting of the Town Council Mr. Gostenhofer moved the confirmation of the proceedings of the Finance Committee, which included a resolution recommending the acceptance of a tender of Mr. John Shaw, of Birkenhead, to erect the buildings in connection with the central electrical generating station in Bentinck-street for the sum of £4,900. Mr. Gostenhofer said it would be remembered that at the last meeting of the Council the Council declined to confirm the tender of Messrs. Holme and Green, of Liverpool, who had asked leave to amend their tender. The Finance Committee again went through the tenders, and now submitted for acceptance the tender of Mr. John Shaw. Alderman Walker seconded. The town clerk (Mr. A. Gill) read a letter from Messrs. Holme and Green, in which those gentlemen said they considered the action of the committee showed a great want of consideration for them. At the committee meeting they were informed that the revised tender was accepted, and they immediately made arrangements for and practically commenced the work. Further, in accordance with the request of the committee, they exposed their estimates and private correspondence to the architect, and they could hardly understand the justice of a summary notice informing them that another tender and a higher one than theirs had been accepted. There was no comment on the letter, and the proceedings of the committee were confirmed.

Wolverhampton.—At the meeting of the Wolverhampton Town Council on Monday last, the Lighting Committee presented the following report with respect to a proposal for the extension of the electric lighting plant: "At a meeting of the Council, held on December 11, 1893, your committee were authorised to apply to the Local Government Board for their sanction to a loan of £30,000 for the purpose of establishing an electric light undertaking under the Wolverhampton Electric Lighting Order, 1890. The sanction to the loan was obtained on February 15, 1894. With the moneys placed at the disposal of your committee the installation has been completed. Since the opening of the works on January 30, 1895, by Lord Kelvin, a continuous supply of electrical energy for public and private purposes has been supplied within the borough. Your committee are pleased to report that the applications for electric light for private purposes have been very numerous, and the consumption consequent upon these demands, in conjunction with the energy required for street-lighting and for the lighting of the municipal buildings, has at the present time nearly reached the total capacity of the existing plant. Your committee anticipate further customers during the coming winter. To enable them to supply the energy required, your committee deem an extension of the plant necessary to the extent hereafter appearing. The success which has attended the lighting of the streets by electricity encourages your committee to erect nine additional arc lamps. These will be placed in Horsley-fields, Snow-hill, Worcester-street, and Chapel-ash. The capacity of the present works, including spare plant, is 8,000 8-c p. lamps. The lamps at present attached to the system, including the nine additional arc lamps, amount to 7,236 8-c p. lamps, leaving a balance of 764 8-c.p. lamps. This narrow margin is insufficient to meet the probable requirements of the coming winter. Your committee, therefore, recommend that the plant be increased in capacity to the extent of 3,300 8 c p. lamps. Tenders have been obtained for the works and machinery in respect of this additional plant, and as it became necessary in order to ensure delivery thereof in time to meet the increased demand, your committee have, subject to the approval of the Council and to the Local Government Board, accepted the following: Messrs. Thomas Parker, Limited, for the supply of electrical machinery, £2 232; Messrs. Marshall and Son, for the supply of an engine, £845; Messrs. H. Willcock and Co., foundations, trenches, etc., £94; Messrs. Callender, Limited, for extension of arc mains and distributing mains, £536; various contractors, for arc lamps, posts, carriers, etc., £268; for steam-pipes, floor-plates, sub-station meters, cables, etc., £250; making a total of £4,225; add for extension of mains necessary as fresh applications for electric light are received, £775; which makes a total of £5,000. Your committee, therefore, beg to recommend (1) that the action of the Lighting Committee, in accepting the tenders of Messrs. Thomas Parker, Limited, Messrs. Marshall and Sons, Messrs. H Willcock and Co., Messrs. Callender, Limited, and other contractors for the works previously enumerated, be approved and adopted; (2) that application be made to the Local Government Board for their sanction to a loan of £5,000 for the purposes previously set forth, and that as and when such sanction has been obtained the Finance Committee be authorised to raise all necessary moneys, either by the issue of Wolverhampton Corporation Stock, or otherwise, as they may deem advisable." On the motion of Mr. Johnson, seconded by Mr. Hollingsworth, the report of the Lighting Committee with regard to the proposed extension of electric lighting of the streets was adopted.

The Victoria-embankment.—The following report of the Highways Committee of the London County Council was submitted on Tuesday; but as the recommendation involves an expenditure on capital account of a sum exceeding £5 000, the consideration of it, in accordance with the standing order of the Council, had to be adjourned for a week: "On July 31 last year we submitted to the Council a scheme for the electric lighting of the Victoria embankment and gardens, and Westminster and Waterloo bridges, for which purpose the Council obtained powers in its General Powers Act of 1893, and £15,000 was provided in the Money Act of that year. The scheme which we then proposed would have involved a capital expenditure of £20,000, being £5 000 over the amount provided for the purpose, and an annual expenditure for maintenance, and for interest and redemption of loan, of £3,880. The Council, upon consideration of the recommendation, resolved that, having regard to the late period of the year, and to the fact that it would be impossible for the electric lighting to come into full operation by the ensuing winter, the further consideration of the question should be adjourned until the spring of this year. We gathered from the discussion on July 31 that one of the reasons which caused the Council to postpone the consideration of the matter was the increase of the estimate by £5,000; and we have accordingly reconsidered the scheme with a view of reducing not only the expenditure on capital account, but also the cost of maintenance. In connection with this revision it has occurred to us that, having regard to the fact that the embankment gardens, which are not open to the public at night, require to be lighted only a very short time each evening for about three months in the year, the Council would scarcely be willing to incur the expense of lighting them by electricity, especially as they are not now lighted at all. We have therefore in the new scheme which we have prepared not made any provision for lighting the gardens, and we think the Council will concur in this. In the revised scheme which we now propose duplicate plant is provided for, either set of plant being capable of lighting the embankment and the bridges; the generating station is of fireproof construction, so securing the maximum of safety; while the cost of the buildings has been reduced by omitting some of the more expensive items of ornamentation proposed in the original scheme, but the buildings will be quite as efficient. The electric lamp standards would be placed on the kerb of each of the footways, leaving the parapet lamps to be lighted, when required, by gas as at present, and the existing lamp standards on the two

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bridges would be fitted with the electric light. It is proposed to provide 83 lamps in all. We would, however, point out that the light on the embankment would necessarily be to some extent obscured by the trees at the sides of the footways, and we do not see our way to obviate this. Should the Council decide to adopt the scheme, we propose to ask the Technical Education Board to allow its inspectors of art schools and classes to assist us by preparing designs for the lamp standards; and we hope to be able to obtain a design for a standard and lamp which will be worthy of being placed in this, the finest thoroughfare in London. The capital cost of the scheme is estimated at £16,590, made up of the following items: buildings £4,600, boilers and machinery £5,200, mains £2 250, lamps and standards £4,240, salaries £300, of which about £3,000 is included in respect of the two bridges. The estimated annual cost of maintenance is £2,768, in which is included—wages £700, coal £375, other stores and carbons £325, repairs £613, loan (interest and repayment) £672, rates and taxes £83. In making these estimates it has been assumed that the repayment of the loan would be spread over 42 years, which is the period for which the Council is now granting loans to vestries for electric lighting purposes. We recommend that, subject to an estimate being submitted to the Council by the Finance Committee as required by the statute, the Highways Committee be authorised to take all the necessary measures for establishing at a cost not exceeding £16,590 electric lighting for the Victoria-embankment and the Waterloo and Westminster bridges (but exclusive of the embankment gardens) authorised by the Council's (General Powers) Act, 1893; and that for this purpose the committee be authorised to obtain tenders and to enter into contracts on behalf of the Council. Mr. Thornton gave notice of the following amendment: "That the Highways Committee be instructed to obtain reports from the engineer and the chemist upon the question whetner the lighting of the Victoria-embankment and the bridges could be improved by the substitution of incandescent burners for those at present in use."

PROVISIONAL PATENTS, 1895.

JULY 1.

12651. **Improvements in electrolytical apparatus.** Richard Heathfield and William Stepney Rawson, 1, Leadenhall-street, London.

12683. **Improvements in or relating to telephone transmitters.** Theodore Berdell, 18, Buckingham-street, Strand, London.

12690. **Improved means for regulating the speed of electrically-propelled vehicles.** Camille Brault and Charles Jeantaud, 47, Lincoln's-inn-fields, London.

12697. **An automatic electric fire alarum and indicator of heavy air in a room or other enclosed space.** August Hansen and Hans Hansen Frimand, 77, Chancery-lane, London.

JULY 2.

12711. **Improvements in or connected with the insulation of copper conductors for electric light wires, cables, telephones, all electrical work, and other purposes.** Joseph Augustus London and Harry Percy Bailey, 29, Eldon-street, Newcastle-on-Tyne.

12719. **An improved filament for incandescent electric lamps.** Joachim Estrade, 70, Wellington-street, Glasgow.

12772. **Improvements in automatic safety devices for electric circuits.** Lewis G. Rowand, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 3.

12824. **Improvements in or relating to engines for ventilating-fans, dynamos, steam launches, and other purposes where economy in space is required** John Walter Gibbs, 6, Lord-street, Liverpool.

12836. **Improvements in automatic electric cut-outs.** Charles Mark Dorman and Reginald Arthur Smith, Ordsal Electrical Works, Salford, Manchester. (Complete specification.)

12869. **Improvements in or relating to automatic electric time calls.** Joseph Lapish Jack, jun., 45, Brook street, Shadwell, London.

12871. **Improvements in electrical circuit closers.** Charles Ambrose McEvoy, 24, Southampton-buildings, Chancery-lane, London.

12888. **Improvements in electric arc lamps.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Jacob Einstein and Sebastian Kornprobst, Italy.)

12893. **Improvements in signal apparatus in combination with tumblers, switches, and switchboxes.** Frederic Barry Stanton, 11, Queen Victoria-street, London.

JULY 4.

12953. **Manufacture of chloride of lead.** The Chloride Electrical Storage Syndicate, Limited, and John Gustaf Adolf Rhodin, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12954. **An improvement in secondary voltaic batteries.** The Chloride Electrical Storage Syndicate, Limited, and George Annesley Grindle, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

12962. **Improvements in electric lighting for vehicles.** Jules Albert Ageron, 18, Buckingham street, Strand, London.

JULY 5.

13014. **Improvements in dynamos and electric motors, the invention being particularly applicable to motors carried in the rudders of vessels.** Anthony George New and Arthur James Mayne, 55, Chancery-lane, London.

JULY 6.

13090. **Improvements in electrolytic cells.** Sebastian Ziani de Ferranti, 27, Charterhouse-square, London.

13091. **Improvements in electric switches.** Sebastian Ziani de Ferranti, 27, Charterhouse-square, London.

13113. **Improvements in telephonic installations.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Ed. Baivy, Belgium.)

SPECIFICATIONS PUBLISHED.

1886.

17018. **Transmitting electric currents in electric rail, etc., systems.** Smith. (Second edition)

1894.

5537. **Electrical deposition of zinc, etc.** Heathfield and Rawson.

7205. **Electro-deposition of aluminium, etc.** Gomess.

12552. **Protecting electric cables.** Nisbett.

12707. **Electric lampholders, etc.** Verity.

13148. **Electrical measuring and recording instruments.** Harrison.

21330. **Galvanic batteries.** Hübner.

1895.

52. **Electric lighting apparatus for railway cars.** Biddle.

4120. **Electric heaters.** Meek.

4610. **Secondary batteries.** Boese.

5313. **Ohmmeters, etc.** Crawley and Soames.

5331. **Recording wattmeters.** Devonshire. (Fish.)

5701. **Arc lamps.** MacIntire.

9056. **Safety appliance for electric circuits.** Siemens Bros. and Co. (Siemens and Halske.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅛-5⅜
Brush Company, Ordinary	3	2⅝-2¾
—— Nom. Cum., 6 per cent. Pref.	2	2⅝-2¾
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5⅛-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	15-16
—— 6 per cent. Cumulative Pref.	10	16-17
—— 5 per cent. Debenture Stock	100	131-134
City and South London Railway, Consolidated Ordinary	100	42-44
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A 1-200 of £50	100	—
Electric Construction, Limited	2	¾-1
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	1¾-2¼
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	1-1¼
Elmore's Wire Company	2	1-1¼
Fowler-Waring Cables	5	¾-1
W. T. Henley's Telegraph Works, Ordinary	10	10½-11½
—— 7 per cent. Preference	10	14-15
—— 4½ per cent. Debentures	100	104-107
House-to-House Company, Ordinary	5	3¾-4
—— 7 per cent. Preference	5	7¼-7¾
India Rubber and Gutta Percha Works	10	20-22
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7-7¼
—— 6 per cent. Pref.	5	7-7¼
Liverpool Electric Supply, Ordinary	5	7¼-7⅝
—— Pref.	—	—
Liverpool Overhead Railway	10	9 15/16-10 1/16
—— Pref.	10	14¾-15¼
—— 4 per cent. Mortgage Debentures of £100	100	110-112
London Electric	5	¼-½
Metropolitan Electric Supply	10	10½-11
—— 4½ per cent. First Mortgage Debenture Stock	100	115-117
National Telephone, Ordinary	5	5⅜-6
—— 6 per cent. Cum. First Pref.	10	16-17
—— 6 per cent. Cum. Second Pref.	10	14½-15½
—— 5 per cent. Non. Cum. Third Pref	5	5¼-6¼
—— 3½ per cent. Deb. Stock	100	105-107
Notting Hill Company	10	8¼-8⅝
Oriental and Electric Company, £1 shares	1	1-1¼
—— £5 Shares	5	7-7½
—— £4½ shares	4½	5¾-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8¼-8⅝
—— 7 per cent. Pref.	5	9-9½
Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	104-107
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4¾-4¾
Westminster Electric Supply, Ordinary	5	7¾-8¼
Yorkshire House-to-House	5	5⅛-5⅜

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NOTES.

Society of Arts.—The council of the Society of Arts have elected Major-General Sir John Donnelly, K.C.B., as chairman of council for the ensuing year. The various committees have also been reappointed.

Personal.—Dr. Barton, of the physical department of the Nottingham University College, has been elected to a fellowship in the Royal Society of Edinburgh, upon the nomination of Lord Kelvin.—Herr Sarasin, director of the electrical experimenting station in Munich, has been appointed controller of the electrical section of the Berlin Industrial Exhibition for 1896.

Electric Organs.—M. Julien Lefèvre begins in *L'Electricien* of July 13 a series of articles, of which the following are some of the sub-titles: "Inconveniences of Mechanical Organs"; "Advantages of Electric Organs"; "The Principle of Electric Organs"; "Historical *Résumé*." An excellent engraving in the first article shows the electric organ in the Church of Saint-Clément at Nantes.

French Submarine Telegraphs.—The *Revue Scientifique* states there are three French companies having submarine cables—namely, the French Telegraph Company, from Paris to New York, with 4,080 miles; the Commercial Cable Company, with seven cables having a total length of 10,495 miles; and the French Society of Submarine Telegraphs, with 15 cables of a total length of 5,260 miles.

Platinum.—The entire platinum output of the Ural Basin, a foreign journal announces, has been sold at very high prices for 10 years ahead. Some years ago this metal cost 2,700 roubles per pood of 36 English pounds. In 1893 an English firm acquired the decadal production of the Tagil Mines at the price of 8,000 roubles per pood. Now a French electrical company has concluded a contract with the remaining Ural mines for the supply of the 10 years' output at the rate of 12,500 roubles.

The Hermite Process.—Major Ruck, R.E., and Dr. Tyndall, from Netley Hospital, have visited Ipswich for the purpose of officially inspecting the Hermite electrical installation now used in the treatment of the Ipswich sewage. Mr. H. J. W. Jervis was deputed by the Mayor to receive the visitors, who, under the guidance of Mr. A. E. Cooper (of the firm of Paterson and Cooper, the engineers), thoroughly entered into the details of the process, and took practical observations upon the results of the treatment, expressing at the conclusion of the visit their appreciation of this system of dealing with the sewage.

Landslip on the Snaefell Electric Railway.—On Friday a workman on the Snaefell Electric Railway named Wm. Tate was engaged in loosening soil, when a large landslip unexpectedly occurred. It completely buried the unfortunate man. The work of extraction was proceeded with as soon as possible, and Tate, who suffered from serious injuries, was removed home. Dr. Miller pronounced the injuries too serious for immediate examination, the chest was badly crushed, hemorrhage was very extensive, the lower part of body was partially paralysed, and there are bruises about the head and face. Tate lies in a critical condition. This is the third serious accident that has befallen this unfortunate man.

The Baule Electric Log.—M. Baule, a retired naval officer commanding the Messageries Maritimes' vessel "La Plata," has devised an electric log which has attracted considerable attention in France. In this new instrument M. Baule returns to the helix, the surfaces of the four comparatively thick copper blades of which are, nevertheless, quite plane. The helix is not attached to the tail of the log, as in the apparatus of M. de Tromelin, but, like the English Massey, Walker, and Garland logs, is towed by a cord, the torsion of which actuates a box-counter, which is either submerged or kept on the sheer-rails. M. Dary, in *L'Electricien* of June 29, says that the French navy now has two electric logs, the qualities of which appear at the moment to be equal—the Fleuriais spoon-mill and the Baule screw instrument.

Electricity v. Gas.—Mr. J. Blacket Gill, who presided at the general meeting of the European Gas Company, Limited, held on Monday at Finsbury House, stated that they could not help being struck with the great inroads which electricity had already made among their consumers, for there were rarely shops of any standing at all which had not got the electric light. There was no doubt that the only way of competing with electricity was to make the price of gas as low as possible; but in the case of their own company this was not such an easy matter, as they worked under very different conditions from London companies. Their company had concessions, and most of the municipal authorities whose towns were lighted by the company were glad to have a "finger in the pie." They could not, therefore, charge as low a price as they would wish, as they had to pay considerable sums to the authorities.

The Electrophone. — We are informed by the Electrophone, Limited, of Shaftesbury-avenue, W., that the "eloquence of Dean Farrar on the occasion of his farewell address will not only reach his devoted congregation at St. Margaret's, Westminster, but his utterances, which cannot but be most impressive, will at the same instant be transmitted through the electrophone to his hosts of admirers in other districts of London, and probably to hospitals, thus enabling the invalided and those unable to be present for want of room and other reasons to avoid missing an intellectual discourse. St. Margaret's, Westminster; St. Anne's, Soho; St. Martin's-in-the-Fields; St. Michael's, Chester-square; the Highbury Congregational, Marylebone Presbyterian, and Christchurch, Birmingham, etc., are the churches amongst the leaders in this interesting and benevolent movement." The communication is dated the 15th inst., but the date of the function has not been vouchsafed by the company.

A New Use for Accumulator-Chests. — The Belgian Customs authorities have discovered an ingenious smuggling trick. In the luggage-van of the express which runs between Paris and Brussels is a case which holds the accumulators when the train is electrically lighted. The guard of the express, a foreman porter, and an excise official of the border station Quèvy possess a key of this case, which, as a rule, no one thinks of examining. The other day, however, as the train ran into Quèvy, a Customs inspector took it into his head to open the chest, and to his amazement he found snugly ensconced therein watches, chains, rings, bracelets, and other dutiable jewellery to the value of 7,000f. The guard and the foreman porter were quietly but firmly detained in Quèvy pending enquiries, which ultimately showed that the porter had for a long period been carrying on a contraband traffic for a well-known jeweller, who, it is said, will be a heavy sufferer by the disclosure of his frauds on the Customs officials.

Long-Distance Telephony.—On Tuesday the trunk telephone wires from London to Edinburgh, Dublin, and other important towns were opened for use by the public. Subscribers of the National Telephone Company in London can make use of the wires through the company's exchange system, and the wires can also be used by members of the

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public at the call offices—at the General Post Office West (corner of Bath-street), the Threadneedle-street (Stock Exchange) Branch Post Office, and the West Strand Telegraph Office (Charing Cross). The wires were fairly patronised by the public, and the Post Office authorities entertain the idea that the new institution will be highly successful. They are under the impression, however, that for effectual long-distance speaking it is necessary to employ double wires, as the single-wire system cannot conduct the sound of the human voice so clearly as is desired. This remark applies to those companies who are anxious to join the Post Office in developing the trunk system.

Automatic Marine Fog-Signal.—A new design of automatic marine fog-signal, the invention of Mr. F. H. Berry, of 14A, Clerkenwell-green, has been fitted to the British India Steam Navigation Company's steamship the "Dunera." The object of the apparatus is to give automatically, at the regular interval required by law, in case of fog, the whistle or bell signals. On the bridge of the vessel is mounted a switch, by turning which the officer in charge can divert an electric current to either the whistle or the ship's bell; the latter, of course, being sounded if the ship is at anchor, and the former when she is under way. The proper interval between the sounds is obtained by clockwork placed in the chart-house, or some other convenient position. The current is generated by means of batteries, the clockwork completing the circuit at the necessary intervals, and in this way electrical energy is obtained for either striking the bell or opening the valve of the whistle. At the same time that the whistle is blown or the bell sounded, a pen is brought into contact with a continuous band of paper, which is marked with divisions. As the paper is wound off at a uniform speed by the clockwork an autographic record is obtained showing when the fog-signals, by bell or whistle, are sounded.

Code Messages.—There is much dissatisfaction at the contemplated enforcement of the Berne "official" vocabulary for code telegraphic messages, and this dissatisfaction, says the *Financial News*, has now been voiced by the New York Coffee Exchange. Its grounds for opposing the compulsory use of the code are (1) that there is no apparent good reason for interference with the existing liberty to employ any word found in the dictionaries of the eight authorised languages; (2) that the proposed official vocabulary is, in various ways, exceedingly faulty; (3) that the contemplated change appears to have been brought forward more to avoid a little occasional trouble for telegraphic officials than to facilitate the work of those who transmit messages; (4) that the necessity for the repetition of doubtful words is likely to be as frequent as it is at present; and (5) that the enforcement of the new vocabulary means the extinction of present codes and their reconstruction and reprinting at enormous expense, not to speak of the great inconvenience occasioned pending the change. The resolutions have been forwarded, it is understood, to the New York managers of the cable companies, with a request that they may be laid before the permanent authorities of the International Telegraph Conference, the next meeting of which is to take place at Budapest in 1896.

Electrically-Lighted Buoys in New York Bay. Incandescent electric lamps on spar buoys have been experimentally used in New York Bay for several years, but an installation has now been completed which marks a considerable advance in maritime engineering and renders the entrance to New York Harbour possible for the largest vessels at any hour of the night. Gedney's Channel, which is the course taken by the Transatlantic steamers, is only 1,000ft. wide, and while buoyed by day, became an impracticable course at night. It is now lighted by 10 incandescent lights of 100 c.p. each, placed on the top of spar buoys on each side of the channel, forming a lighted avenue for the shipping. The lamps are mounted on 50ft. cedar buoys which are shackled to 5,000lb. mushroom anchors. The cable is constructed of a copper conductor, insulated with guttapercha, then bedded with jute and sheathed with an armour of hard-drawn copper wires. This cable carries successfully, according to the *Engineering Record*, an alternating current at a pressure of 1,000 volts under water for a distance of 6½ miles. The generating station is located about 2,000ft. from the beach. The current for lighting the buoys is carried to the submarine cable through a lead-covered conductor laid in a creosoted subway 4ft. underground. The electric plant is in duplicate. The current is generated at 100 volts and is raised by a step-up transformer. All the high-tension lines are either underground or in cables at the bottom of the sea.

Science Research Scholarships.—Her Majesty's Commissioners for the Exhibition of 1891 have made the following appointments to science research scholarships, for the year 1895, on the recommendation of the authorities of the respective universities and colleges. The scholarships are of the value of £150 a year and are tenable for two years (subject to a satisfactory report at the end of the first year) in any university at home or abroad, or in some other institution approved of by the commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country. University of Edinburgh, John D. F. Gilchrist, M.A., B.Sc.; University of Glasgow, Walter Stewart, M.A., B.Sc.; University of St. Andrews, Henry Charles Williamson, M.A., B Sc.; University College, Dundee, James Henderson, B.Sc.; Mason College, Birmingham, Robert Howson Pickard*; University College, Bristol, Samuel Roslington Milner*; University College, Liverpool, John Taylor Farmer, B.Sc.; University College, London, Emily Aston, B.Sc. Owens College, Manchester, William Henry Moorby, B.Sc.; Durham College of Science, Newcastle-on-Tyne, Alexander Lawson Mellanby, A.Sc.*; University College, Nottingham, Martin Ernest Feilmann; Queen's College, Belfast, William Hanna, M.A.; McGill University, Montreal, Robert Owen King, B.Sc.; Queen's University, Kingston, Canada, Thomas Leonard Walker, M.A.; University of Sydney, John Alexander Watt, M.A., B.Sc.; University of New Zealand, Ernest Rutherford, M.A. * Conditional appointments.

Transformer-Chambers in the Streets.—The Highways Committee of the London County Council on Tuesday reported that the County of London and Brush Electric Lighting Company had asked the Board of Trade to give a definite decision upon the appeals of the company which were the subject of an enquiry by the Board of Trade in December. On February 24 they reported that the Board had intimated that it was not prepared to hold that sufficient reasons had been advanced, either on the ground of public safety or of want of parliamentary sanction, to justify the Board in refusing to approve of a system of supply involving the use of transformer-chambers in the public streets, and that the Board hoped that this decision on the general question would render unnecessary any further action on the appeals lodged by the company. The Board afterwards approved a description of the system of supply under the County of London (North) Order, 1892, which contained the following words: "The converting stations

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will be street boxes of sufficient size and suitable construction to contain several transformers, room being also provided to enable a man to enter the box and conveniently examine the transformers and controlling apparatus." The Board of Trade had decided to hold a further enquiry into the matter, at which it was thought desirable that the Council should be represented by counsel. The Council adopted the recommendation of the committee that they should be authorised to take all necessary measures for making known at the Board of Trade enquiry the Council's objections to the transformer-chambers being placed under the public streets.

Electric Light Station in Shanghai.—The new electric light station which the Municipal Council of Shanghai are erecting at the corner of Yuheng and Fearon roads is, says the *Shanghai Gazette*, of bold and handsome proportions, its design having evidently been to combine a striking exterior with internal adaptability to the purpose for which the edifice is intended. The building throughout is constructed of blue and red brick, and the most striking feature about it is, of course, the tall chimney, which will be the largest in Shanghai, measuring 120ft. in height, with an internal diameter of 7ft., the outside diameter at the base being 20ft., from which it will gradually taper to 13ft. at the top. The engine-house measures 116ft. in length, 85ft. in breadth, and 25ft. in height. It is intended to place no fewer than 14 compound horizontal surface-condensing engines by Marshall and Co., of Gainsborough, whose machinery seems to be growing in popularity in China, there being now, our contemporary states, some 40 engines manufactured by them working in Shanghai alone. The dynamos for arc lighting are by the Brush Company, of Cleveland, Ohio, U.S.A., and the alternators, switches, transformers, and such instruments are the work of the Brush Company, of England. The boiler-house is also a very spacious and lofty apartment in which will be placed three Lancashire boilers, each measuring 7ft. by 28ft., and capable of sustaining a daily working pressure of 140lb. These three boilers are the largest of the description in Shanghai. There will also be two locomotive boilers working at the same pressure. Adjoining the electric light station are two airy dwelling-houses for the superintendent and assistant superintendent. The superintendent's office and workshop adjoining will be fitted with all of the most modern electrical appliances. All the buildings are roofed with galvanised corrugated iron, with the exception of the dwelling-houses, which are roofed with Marseilles tile.

The Campden Technical Institute.—On Tuesday, on a piece of ground adjoining the public library in Lancaster-road, North Kensington, the foundation-stone of a new technical institute in connection with the Campden Charities was laid by Princess Louise, Marchioness of Lorne. On the platform, over which a prettily-decorated marquee had been erected, were the Rev. the Hon. E. C. Glyn (chairman of the Building Committee), who presided, Mr. Wyndham Gibbes (deputy-chairman of the Building Committee), Sir Algernon Borthwick, Dr. Gladstone, Canon Trench, Mr. William Bousfield, and others who have interested themselves in the movement. It appears that the building is to be on a site purchased for £2,526, mainly defrayed from money subscribed in response to an appeal by the Marquis of Lorne. As the amount given by the public in Kensington was insufficient to complete the purchase and to erect a polytechnic institute, the Campden trustees, with the consent of the Charity Commissioners, granted the sum of £5,000 for the purpose. As soon as the institute is completed, the evening classes in woodwork, wood-carving, drawing, dressmaking, and cookery now maintained by the trustees in North Kensington, and at present meeting in different places, will be moved into the new building, and it is hoped that further donations from the inhabitants of Kensington will enable the trustees at some future time to add a gymnasium and other manual and technical classes. There is at present no polytechnic institute within reach of the crowded working-class district of North Kensington, and the trustees are unable to create out of their funds an organised polytechnic similar to those existing in other parts of the Metropolis. The building is to be two storeys in height, and in red brick, with stone dressings. The whole of the ground floor is to be set apart for the boys, and the first floor for the girls. The architect (honorary) is Mr. Rowland Plumbo, of Fitzroy-square. In addition to laying the foundation-stone, Princess Louise, who met with a hearty reception from a large crowd on her arrival and departure, gave away the prizes gained by the girl students attached to the polytechnic.

The Metric System.—In answer to the questions sent out by the New Decimal Association, Mr. C. S. Smith, British Consul at Bilbao, in his commercial report for the year 1894 observes: "I have spoken to a good many people on this subject. Although everyone feels that the difference of units is a difficulty in the way of trade, and therefore must have the effect of in some measure reducing its volume, no one has been able to name a single specific case where the difference has prevented an order from being given to an English firm. The difficulty appears to me to be of the same nature as that presented by differences of language. I do not gather that it is contended that British goods are made of sizes that are not required, only that they are described in measures which are not understood by purchasers. The proposal is to change the way of describing the articles to be sold, not their dimensions. If I wrongly understand the contention, I would point out that the dimensions of the goods are independent of the standards used to describe them, and it may be supposed that any required size of goods could be manufactured without first adopting the decimal system. If, on the other hand, it is desired to overcome the difficulty of making our measures intelligible to the foreign purchasers, and to avoid waste of time and labour in conversion, it might be observed that the use of tables makes conversion quick and easy, and that there seems to be no reason why price lists should not be made out so as to give metric equivalents to dimensions in English measures, exactly as at present lists are made out which give Spanish names and descriptions for British goods. Firms which would take the trouble of doing this would be able to report whether they have gained any considerable increase of customers from it, and this experience would help the future consideration of the question. I have been asked to treat this matter from the point of view of foreign trade. I am bound to say that, as far as my enquiries go, foreign trade does not furnish adequate reason for the British Empire to undergo the inconveniences of making the change. So as not to be misunderstood, I should add that my personal vote would be for the change, even though the metre be not what it was once supposed."

High Speed of Electric Motors.—Some interesting trials on the Nantasket branch of the New York, New Haven, and Hartford Railroad took place on June 20 and 22. The Nantasket Beach branch was chosen for the experiment for the reason than within its limits will be included most of the different problems which will have to be determined to make electricity a successful substitute for steam. The curves are many and sharp, the grades are

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steep, and trains will be run with great frequency. Seven miles is the distance between the Old Colony station and Pemberton. The tracks are 15ft. apart from centre to centre, and between the tracks is a single line of poles on which are supported the cables and trolley wire. Upon the tangents the poles are set with such geometrical precision as to secure absolutely perfect alignment. The two flexible copper bonds, 7in. long, are under the base of the rail at each joint and riveted to each rail. A power-house, No. 1, is situated midway between the terminals and contains two tandem compound engines; the two generators develop 1,500 h.p. each. Four motor cars have been built after the style of baggage cars. To secure traction they have been made extra heavy, so that when fully equipped they will weigh about 60,000lb. each. Two will have four motors each and the other two motors each hung on trucks. The cars are equipped with the Westinghouse air-brake, and in addition to a 15in. gong there will be a chime whistle worked by compressed air. The test was held in the presence of only a few invited guests. There was none of the gradual increase of speed characteristic of the steam locomotive. A test was made of a load of 175 tons, equal to a train of seven cars, but the ease of starting and the speed obtained showed that a load of three or four times as great could be easily drawn. A speed of more than 50 miles an hour was obtained, and for a part of the distance it was estimated that the train made at times the enormous speed of 80 miles per hour. A hot box prevented a greater increase of speed. When the train was making 80 miles an hour there were still five notches left in the "controller" in the motor, so that if the additional current had been applied, it is thought that a speed of 90 miles an hour might have been obtained on the level stretches.

Thermo-electric Properties of Pure Metals.—Herr K. Noll, in *Ann. Phys. Chem.*, states that, owing to considerable differences between the observations of different workers on the thermo-electric properties of metals, he redetermined the E.M.F. for various combinations, employing metals in as high a state of purity as was obtainable. In the first series of experiments the second metal was in all cases mercury and the temperatures of the junctions 100deg. and 0deg. The E.M.F. was determined by Du Bois Raymond's modification of Poggendorf's methods, Clark cells being employed as the source of the constant E.M.F. The results of these researches (expressed in microvolts) are contained in the following table, + values indicating a current from mercury to metal at the hot junction:

Bismuth	−6,705·4	Carbon rod ...	+ 662·88
Nickel	−1,664·2	Silver	+ 710·25
Cobalt	−1,522·2	Gold	+ 713·35
Nickel silver	−1,085·2	Copper.....	+ 725·58
Platinum.....	+ 4·59	Zinc	+ 692·71
Aluminium...	+ 362·4	Cadmium.....	+ 875·09
Magnesium...	+ 391·84	Carbon filament	+1,452
Tin	+ 396·03	Iron	+1,601·4
Lead	+ 402·5	Piano wire ...	+1,732·3
Brass	+ 443·31	Antimony ...	+3,379·6

In many cases the effect of small quantities of impurity was very great. Thus platinum gave values as high as +593·88 and copper as low as +684·29 when the metals were not chemically pure. The state of aggregation had also a marked effect in some cases—for instance, silver (710·25; 671·51), zinc (692·71; 735·2), iron, brass, nickel. The second series of experiments was performed at various temperatures between 217deg. and 0deg., a number of experiments being made in each case. From the results the value for 100—0deg. was calculated, good agreement with the observed value being in all cases obtained. The junctions were in some cases formed with mercury, in others with copper. The E.M.F. is given according to Gaugain by formula $\epsilon = (t_1 - t_2)\{b \pm c(t_1 + t_2)\}$. The values for b and c are deduced from two experiments, and the results calculated by their aid compared with the observations. The agreement is perfectly satisfactory. The value $\frac{d\epsilon}{dt} = b \pm ct$ is then calculated, and as this can be expressed as $b \pm (k_2 - k_1)\,t$, where k_2 and k_1 are the constants for the different metals of the junctions, the numbers are referred to lead, for which $k = 0$. The values thus obtained for the thermo-electric power $\frac{d\epsilon}{dt}$ are compared with those of other observers. The difference in the result may be explained by the effect of impurities which, as is evident from the numbers, produce considerable variations.

The Chronoscope.—It is stated that what is claimed to be the most wonderful timing instrument in the world was exhibited before the members of the Department of Pedagogy and Psychology of the Brooklyn Institute of Arts and Sciences recently. It is called a pendulum-chronoscope, and has excited widespread interest in the scientific world. It measures accurately down to the one-thousandth part of a second, and is expected to take the place at once of the old-style chronoscopes in scientific laboratories. The idea of the instrument was originally suggested by Prof. Charles B. Bliss, of the School of Pedagogy of New York University. The machine was made and perfected by Mr. J. J. Hogan, the head of the mechanical department of the Psychological Laboratory of Yale. It can be used with the quickness of a stop watch, and neither electrician nor mathematician is needed as operator. Constructed on the pendulum principle, it measures the reaction time between sight, hearing, or the operation of the will in muscular movement. The instrument is a mechanical one, with simple electrical attachments. The speed of a cannon-ball can be determined by the new timer, and it will tell the lapse of time between the firing of a revolver and the starting of a runner, or determine how long it takes a boxer to deliver a blow. The new instrument is about 2ft. high, and is mounted on silver and nickel. It costs about £40 to construct it. A simple description of this machine is that it consists of a pendulum and a pointer swinging independently on the same axle. The tip of the pointer swings along the face of a curved scale or indicator, which is so graduated that it shows the one-thousandth of a second. To measure the time required for the transmission of any given impression a button is pressed, and this sets the pendulum in motion and registers the result on the scale. It has been demonstrated that on an average the reflex action for sound occupies 0·130 of a second. In making a sight test when the pendulum comes in contact with the pointer a black shutter is raised from a light disc. As the disc flashes on his sight the subject touches the button and the pointer is at once stopped. It has been found that 0·300 of a second is the average time between the exposure of the disc to the sight and the pressure of the button. A test for discrimination is to exhibit from behind the shutter a square of some colour. The person operated upon does not know what colour may be exhibited. He is told, for instance, to press the button when he sees blue. Such a test will involve a longer time, perhaps the one-fourth of a second altogether. Other trials are made with odours, sounds, or pin-pricks. An Italian machine for making these tests is moved by clockwork and exhibits the results upon two dials, the one marking hundredths and the other thousandths of a second. The value of these tests for the purposes of the School of Pedagogy is to enable teachers to know what the mental characteristics of their

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scholars really are. Under the system of teaching of a generation ago no one paid any attention to this in dealing with pupils. Schoolmasters in those days, in fact, did little or nothing in the way of teaching. The routine of a school then consisted in a master's telling his classes what pages of the books the lessons for the next day were to be found upon, how long the lessons would be, and hearing the scholars recite.

Condensation of Electrolytic Gas.—Messrs. Louis P. Caillett, Emmanuel Collardeau, and Marcellin Berthelot, in *Comptes Rendus*, describe the condensation of electrolytic gas by porous substances, especially by metals of the platinum group. Spongy platinum was enclosed in two small silk bags, together with a platinum wire to serve as a conductor, and immersed in dilute sulphuric acid (1 : 10), one bag forming the anode and the other the cathode. An electric current was allowed to pass until the platinum was presumably saturated with the two gases, and the two bags were then placed in electrical communication so as to form a gas battery similar to that of Grove. Under these conditions a much more powerful and persistent current is obtained than with the same weight of platinum in the ordinary metallic condition, and the duration of the current is greatly increased under pressure. Under atmospheric pressure the discharge lasts only about 10 seconds and the E.M.F. falls continuously from 1·8 volts to zero. Under gradually increasing pressure the manner of discharge gradually alters and three periods are recognisable. There is first a period of very rapid fall in the intensity of the current, which afterwards rises slightly; this is followed by a period of constant intensity, the intensity slightly increasing with the pressure, and the E.M.F. being about one volt; finally, there is a period of fall less rapid than the first. The capacity of the accumulator thus formed by the spongy platinum is 56 ampere-hours per kilo. of metal under a pressure of 580 atmospheres, and the intensity of the current may easily reach 100 amperes per kilo. In order to obtain the best results, about three times as much platinum should be used for the negative pole as for the positive. The yield of the accumulator is as high as 95 or even 98 per cent., provided that the charge is not pushed to its limit, and that the discharge begins immediately after charging. Iridium behaves like platinum; ruthenium is slightly attacked at the positive pole, but will also form an accumulator with a capacity that increases with the pressure, but with an E.M.F. that is not constant but decreases continuously from 1·6 volts to zero, whatever the pressure. Palladium in the metallic form constitutes an accumulator of very feeble capacity, owing to the rapidity with which it is saturated by oxygen; but in a spongy condition it gives results much better than those obtained with any other metal of the platinum group, and even under atmospheric pressure is equal to platinum under a pressure of 20 to 30 atmospheres. As the pressure increases the phenomena are similar to those observed with platinum, but the capacity of the accumulator is three or four times as great, and under a pressure of 600 atmospheres may reach 176 ampere-hours per kilo. Gold precipitated by sulphuric acid behaves like the platinum metals, but the capacity is lower and the intensity of the current varies somewhat differently. Silver, tin, nickel, cobalt, and carbon undergo change at the positive pole, and although there is some accumulation of electrical energy, it is not affected by pressure and seems to be due to chemical changes. Berthelot points out that platinum, palladium, and analogous metals form definite compounds with oxygen, and especially with hydrogen, at the ordinary temperature, their formation being influenced by pressure.

The Mulhouse Industrial Society Prizes.—Unlike some other French and German institutions, the Société Industrielle de Mulhouse opens its prize competitions to foreigners. Among the premiums offered by the society for 1896 are the following: A silver medal for an application of electricity in the printing industry.—A silver medal and the sum of 500f. for the invention and application of a pyrometer for registering the temperature of the gaseous products of the combustion of coal in boiler furnaces. An instrument is required capable of indicating to within 5 per cent. the temperature of a gaseous current between the limits of 300deg. and 800deg., the apparatus itself to be in the midst of the gases, the temperature to be read outside the furnace. The prize will only be awarded to an instrument which has been in use for at least six months in connection with a steam-boiler in Upper Alsace. — Medal of honour for a practical installation in an Upper Alsatian industrial establishment for distributing motive power to a plant through an electrical network fed from a private or public central generating station. The installation should have been working for a year in Upper Alsace; and it should, among other advantages, be appreciably cheaper than the distributing method hitherto employed. The medal will be granted not only to the inventing engineer but also to the establishment in which the installation was carried out.—Medal of honour for a 10-h.p. electric motor capable of developing a variable energy and speed at will.—Prize (to be afterwards fixed) for a new, simple, and practical method of fixing armature wires to the commutators. The new system should allow of the easy changing of the collectors and facilitate, if possible, the investigation of faulty insulation of the armature wires; and should assure a good contact of the wires with the bars of the commutator. The application of the new method to any kind of drum or cylindrical (Gramme) ring is to be dealt with. The treatise should enumerate the advantages and disadvantages of the present systems and compare them with the new method proposed.—Medal of honour for a memoir treating of the comparative cost of an electric and a gas installation, both required to supply light to a town of at least 30,000 inhabitants. The comparison should deal particularly with the following points: (1) cost of the central station and of the gasworks, of the electric distribution and of the gas-mains, of the domestic fittings; (2) cost of the coal essential for the production of power at the central station and the gasworks; (3) cost of working and maintenance in the two cases. A special chapter should be devoted to a detailed account of the resulting expenses and receipts—in the case of the gasworks the value of the by-products to be taken into consideration. Another chapter should treat, being based upon a fair number of experimental determinations, of the photometric value of gas-burners of a given consumption and of the electric lamps which are usually substituted for them.—Silver medal for a treatise on the comparative cost of an electric and a gas installation, of at least 300 lamps, both required to furnish light to an industrial establishment. The different kinds of electric lighting should be dealt with, and the cost of working compared with that of a gas installation. A special chapter should be devoted to a comparison of the intensities of light obtained in the various instances. All treatises, drawings, models, etc., should be marked with a motto, and forwarded before February 15, 1896, to M. le Président de la Société Industrielle de Mulhouse, together with a sealed letter containing the full name and address of the competitor. Anyone may obtain a copy of the programme of the prizes to be grant by applying to the Secrétariat of the society.

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ON A METHOD OF DETERMINING THE THERMAL CONDUCTIVITY OF METALS, WITH APPLICATIONS TO COPPER, SILVER, GOLD, AND PLATINUM.*

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Communicated by LORD KELVIN, P.R.S.

(Concluded from page 41.)

The calorimeter ball most frequently used in the present work was turned from the solid, and is 5·5cm. in diameter. This was found to be a very convenient size for the metals of high conductivity—for example, gold, silver, and copper. Any length from 4cm. to 8cm. of wires of these metals may be used without making it difficult to read the rise in temperature per minute. It is not advisable to use lengths shorter than 4cm., as there is then a danger of the water-jacket being too near the heating-box, but it is better to use a smaller ball, say, of 4cm. diameter, for metals of lower conductivity. For metals having conductivities between 1·0 and 0·7 C.G.S. units, the large ball was found to be quite convenient; for lower values the smaller ball was used. The object aimed at was to arrange the dimensions so as to enable an experiment to be finished in less than half an hour from the time that one end was made hot by the boiling water.

After the wire has been soldered in, the box is placed in the screen, L (Fig. 2), and fixed by any convenient means, so that the wire hangs vertical, and the asbestos cover is put over the box. The cardboard tube, having been made of suitable length, and slit along its length, is now slipped round the wire, and, after a little cotton is loosely packed in, the slit is closed up by means of a strip of gummed paper. The wire is now completely enclosed in this tube and loosely surrounded by cotton wool.

The thermometer is placed in the hole in the ball, and a little water put in to fill up the hole. The water-jacket may then be raised so as to surround the ball, and the top of the water-jacket must be covered with two or three sheets of paper, holes having been cut in these, so as to admit the wire and thermometer.

It was found best to make these preparations a few hours before the actual test was begun, so as to allow the system to take up a permanent temperature. When it has been ascertained that this temperature has been reached, a reading is taken from the thermometer in the ball. The thermometer used was most carefully made and calibrated for the tests by Mr. Otto Müller, of Glasgow. The whole length of the stem is 15cm., and it is marked off to read twentieths of a degree from 9deg. to 20deg. C. Each division is ½mm., so it is perfectly easy to read to one-fortieth of 1deg.

Before beginning the test the water-jacket is lowered, and a vessel containing ice and water raised so as to cover a part of the ball. By this means the temperature of the ball is lowered by 6deg. or 7deg. below that of the air. While this is being done, the boiling water is poured into the box, so as to nearly fill it, and the Bunsen lamp lit. The water soon begins to boil rapidly, and the thermometer (which is 12cm. long and reads from 95deg. to 105deg. C.) indicates a constant temperature, usually 97deg. or 98deg. C. When the temperature of the ball has been lowered 6deg. or 7deg., the ice and water are taken away, and the ball is carefully dried with a soft cloth. The water-jacket is again placed so as to surround the ball and the cover put on as before, the circulation of water in the jacket having been started.

It is now only necessary to take readings of both thermometers every half-minute. The temperature of the hot water will be practically constant, but it is advisable to take the readings in case of alteration. The calorimeter thermometer may be read till it reaches 20deg. C.

It will be convenient to explain here the reason for cooling the ball 6deg. or 7deg. before starting. In the preceding remarks no notice was taken of the fact that there will be radiation to or from the surface of the ball unless the latter is at the same temperature as its surroundings. It would be impossible to allow for this by calculation, as the surface is altered before every test by being heated while the wire is being soldered into the ball. For the purpose of getting rid of the necessity of allowing for this radiation the ball is cooled.

Let Q_1 = the quantity of heat which flows along the wire in unit time when the hot end is at T degrees and the cool end at θ degrees above the temperature, t, of the air and water-jacket, and let Q_2 = the quantity when the cool end is θ degrees below that of the air.

Then, assuming that the conductivity does not change very much through 2 θ degrees, and that α, the loss by radiation in unit time when the ball is θ degrees above the air temperature, is equal to the gain by absorption in unit time when the ball is θ degrees below the air temperature, we have

$$Q_1 = \frac{K A}{l}[T - (t + \theta)] - \alpha,$$

and

$$Q_2 = \frac{K A}{l}[T - (t - \theta)] + \alpha.$$

Therefore

$$\frac{Q_1 + Q_2}{2} = \frac{K A}{l}(T - t).$$

It is seen by the last equation that the effect of radiation to or from the surface of the ball is completely eliminated, since the coefficient of emission is numerically equal to the coefficient of absorption for the same difference of temperatures. It, therefore, fortunately does not matter how the surface of the ball becomes changed, so long as it remains the same during the half-hour of the experiment. As a matter of fact, during the soldering process the surface becomes very much tarnished. Table I. gives a specimen experiment taken at random from my laboratory book.

TABLE I.—Friday, March 23, 1894.—Pure Silver Wire (annealed). Length = 6·59cm. Diameter = ·202cm. Temperature of air = 14·3deg. C.

I. Reading taken every ½-minute. Deg. C.	II. Temperature of hot end. Deg. C.	I. Reading taken every ½-minute. Deg. C.	II. Temperature of hot end. Deg. C.
10·3	98·2	14·75	98·3
10·5	98·2	14·9	98·4
10·75	98·2	15·1	98·6
10·95	98·3	15·25	98·5
11·15	98·2	15·45	98·6
11·35	98·2	15·6	98·4
11·55	98·3	15·75	98·4
11·75	98·3	15·9	98·6
11·95	98·2	16·05	98·5
12·15	98·3	16·25	98·6
12·35	98·2	16·4	98·6
12·55	98·3	16·55	98·6
12·75	98·5	16·7	98 6
12·95	98·3	16·85	98·6
13·1	98·4	17·0	98·6
13·3	98.3	17·15	98·6
13·5	98·4	17·3	98·6
13·65	98·3	17·45	98·6
13·85	98·4	17·6	98·6
14·05	98·4	17·7	98·7
14·25	98·4	17·86	98·6
14·4	98·4	18·0	98·6
14·6	98·3		

The numbers in Column I. are put on a curve, as shown in Diagram II. From this curve the rise in temperature in half a minute is read off for x degrees above the temperature of the air, and this is added to the rise for x degrees below the temperature of the air, where x is any value from 0 to 5 or 6. In this way as many as 10 or 15 values are obtained. If the curve were quite regular, each of these values would be the same, since they each represent the rise in temperature per minute for the same difference of temperature, but they are found to vary by about 1 or 2 per cent. But by taking the mean of 10 or 15 values, it will be seen that the result obtained must be very near the correct value for the rise between the given temperatures. It is then only necessary to multiply this rise in temperature by the thermal capacity, C, of the ball to find the quantity of heat that has passed along the wire in one minute, and the conductivity can be calculated from the formula

$$K = \frac{C\,\theta\,l}{\pi r^2 (T - t)\,60},$$

where r is the radius of the wire.

* From the *Philosophical Transactions* of the Royal Society of London.

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In order to obtain an accurate determination of the thermal capacity of the ball, I took it to Dublin, where the capacity was most carefully determined for me during the time I was there by Dr. John Joly, F.R.S., by his most ingenious steam calorimeter method.* I have to thank Dr. Joly for the trouble to which he put himself in making the determination.

As the most important thing in testing the method is to show that with different lengths the resulting determination of the conductivity remains practically the same, these series of tests and the results will be given first.

The wire first used was what was called six years ago high electrical conductivity copper. The diameter was 2·1mm., density 8·85, volume specific (electrical) resistance, 1834 in electromagnetic units. This wire was almost exclusively used, but in the course of the work tests were made of wire got from Messrs. Glover and Co. in the end of the year 1890. Messrs. Glover's wire was found to have considerably higher conductivity, both electrically and thermally, than the first-mentioned wire, which for convenience will be called the laboratory copper, as it was what used for all the electrical work in the laboratory. Taking the laboratory wire as 100 per cent. conductivity (thermally and electrically), it was found that Messrs. Glover's wire was 106·6 per cent. electrical and 108 per cent. thermal conductivity.

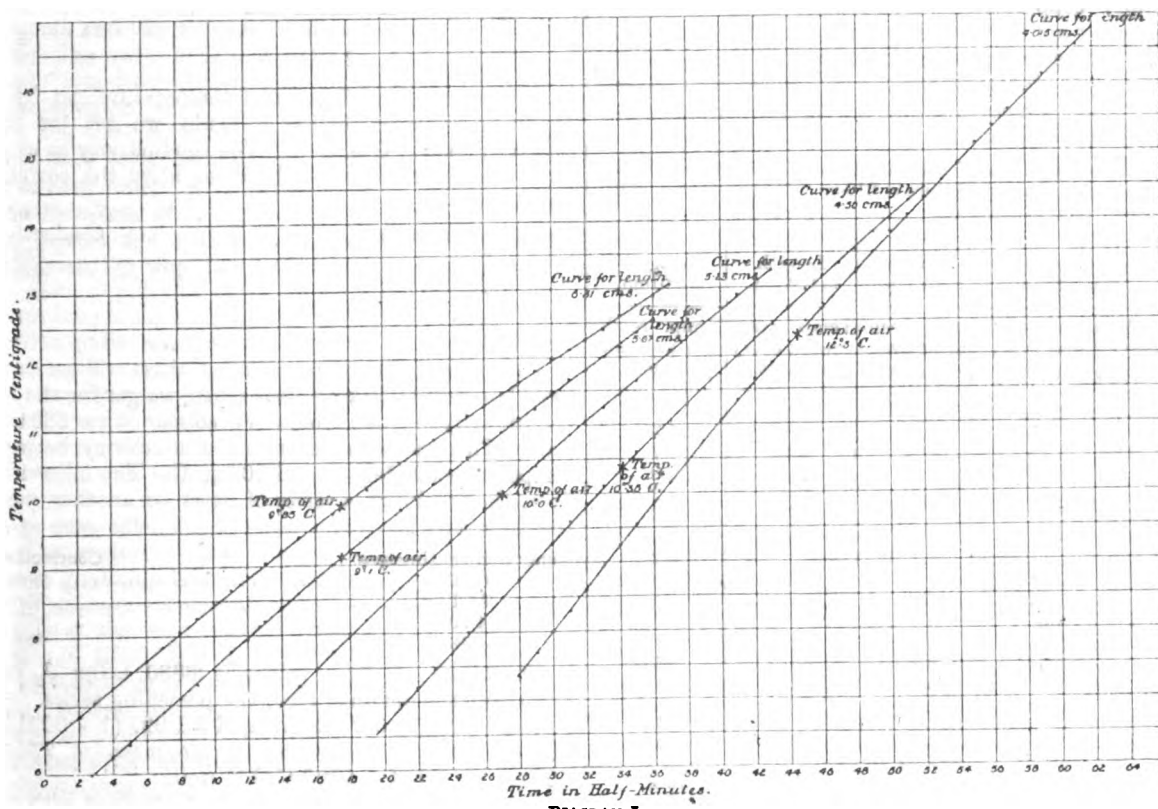
Curve for length 4·05 cms.
Curve for length 4·36 cms.
Curve for length 5·13 cms.
Curve for length 6·31 cms.
Curve for length 5·03 cms.
Temp. of air 12·5 C.
Temp. of air 10·50 C.
Temp. of air 10·0 C.
Temp. of air 9·85 C.
Temp. of air 9·1 C.
Temperature Centigrade.
Time in Half-Minutes.

DIAGRAM I.

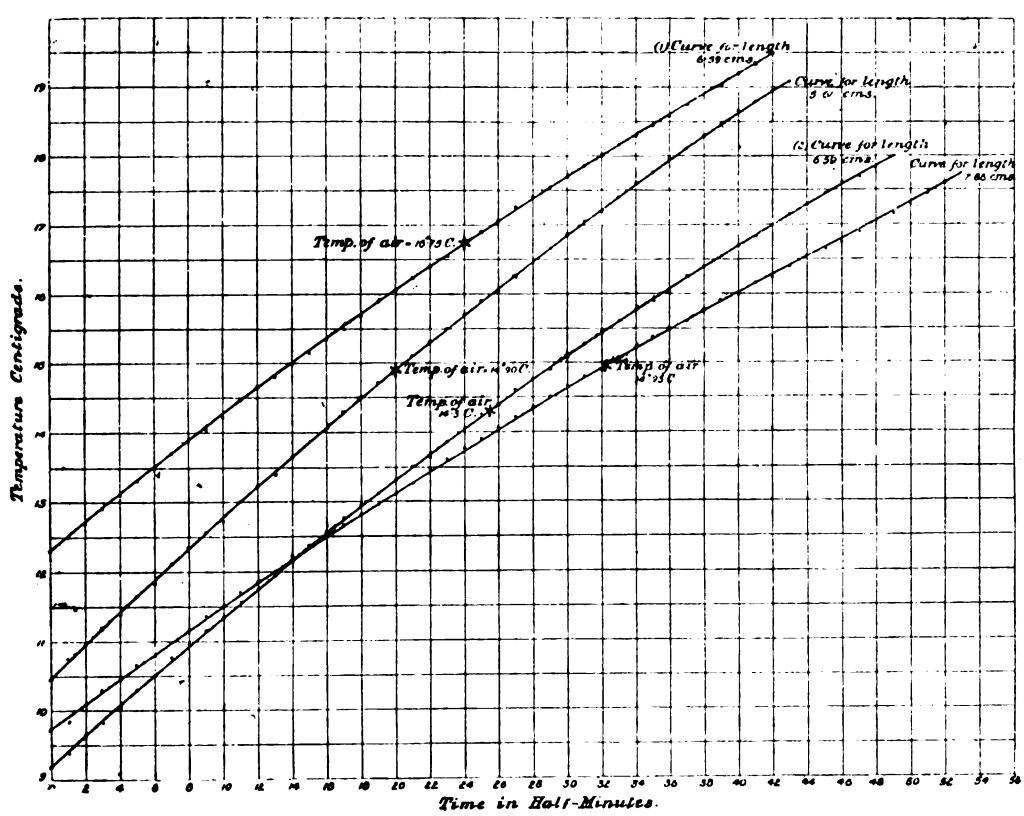
(1) Curve for length 6·39 cms.
Curve for length 5·01 cms.
(2) Curve for length 6·30 cms.
Curve for length 7·85 cms.
Temp. of air - 16·75 C.
Temp. of air. 14·90 C.
Temp of air 14·25 C.
Temp of air 13 C.
Temperature Centigrade.
Time in Half-Minutes.

DIAGRAM II

* J. Joly, *Roy. Soc. Proceedings*, vol. 41, p. 352, 1886.

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These results will be referred to further on. They are merely mentioned here to show that the best conducting wire was not used for the exhaustive tests.

Table II. shows the record of series of experiments made on laboratory copper wire. The wire was soldered into the heating-box and ball as described; an experiment was made and the length measured carefully. The ball was then heated by a blow-pipe flame to allow the wire to be taken out. A short piece was then cut off and the shortened wire again soldered into the ball.

TABLE II.—Showing Rise of Temperature of Calorimeter Ball with Time. Diameter of wire = ·210cm. Temperature readings taken every ½-minute.

Length =6·31cm.	Length =5·87cm.	Length =5·23cm.	Length =4·39cm.	Length =4·01cm.
Temp. reading at every ½-minute.	Temp. reading at every ½-minute.	Temp. reading at every ½-minute.	Temp. reading at every ½-minute.	Temp. reading at every ½-minute.
Deg. C.	Deg. C.	Deg. C.	Deg. C.	Deg. C.
6·45	6·25	7·0	6·65	7·35
6·65	6·45	7·25	6·95	7·7
6·85	6·7	7·5	7·2	8·0
7·05	6·9	7·75	7·45	8·3
7·25	7·1	8·0	7·7	8·6
7·45	7·3	8·2	8 0	8·95
7·65	7·5	8·4	8·25	9 25
7·85	7·75	8·65	8·5	9 55
8·05	7·95	8·85	8·75	9·85
8·25	8·2	9·1	9·05	10·15
8·45	8·4	9·35	9·3	10·40
8·65	8·6	9·55	9·6	10·75
8·85	8·8	9·8	9 85	11·05
9·05	9·0	10·0	10·1	11·36
9·2	9·2	10·2	10·35	11·65
9·4	9·4	10·4	10 6	11·9
9·55	9·6	10·65	10·8	12 2
9·75	9·8	10 85	10·05	12·5
9·95	10·0	11·05	11·3	12·75
10·1	10·15	11·25	11·5	13·0
10·3	10 35	11·45	11·75	13·25
10·45	10·55	11·65	12·0	13·5
10·65	10·75	12·1	12·25	13·8
10·85	10·9	12·3	12·45	14·05
10·95	11·1	12·5	12·7	14·3
11·15	11 25	12·7	12·95	14·55
11·3	11·45	12·9	13·15	14·8
11·45	11·65	13·05	13·35	15·1
11·6	11·8	13·25	13·56	15·35
11·8	12·0	—	13·8	15 6
11·95	12·15	—	14·0	15·85
12·1	12 35	—	14·25	16·1
12·25	12·55	—	14·45	16·8
12 4	—	—	—	16·55
12 6	—	—	—	16·8
12·75	—	—	—	—
12·9	—	—	—	—
13·05	—	—	—	—
Temp. of air, 9°·85 C. Temp. of hot water 97°·3C.	Temp. of air, 9°·1 C. Temp. of hot water 97°·0C.	Temp. of air, 10°·0 C. Temp. of hot water 97°·0C.	Temp. of air, 10°·35 C. Temp. of hot water 96°·4C.	Temp. of air, 12°·3 C. Temp. of hot water 96°·7C.

The temperature of the hot water varied not more than ½deg. during an experiment, and the value given in each column of the preceding table is the mean throughout the time. The columns of temperatures were, immediately after an experiment, put on a curve with time as abscissæ. The effect of radiation to and from the calorimeter ball is fairly well marked. At the point corresponding to the temperature of the air in each curve there is an increase of curvature, caused by the fact that the radiation has changed from negative to positive.

In order to find the flow of heat, the rise of temperature per minute was read from the curve at a temperature $x$deg. below that of the air, and this was added to the rise for $x$deg. above that of the air. x varied from 0deg. to 4deg. or 5deg. By this means from 10 to 15 readings were got, and the mean of these gave the rise at the temperature of the air. For example, for the length 6·31cm. in the first column of Table I., the rise thus obtained from the curve, Diagram I., was ·3605 in one minute. The capacity of the ball and of the part of the thermometer with the water in hole was found to be 68·9.

There
$$K = \frac{68{\cdot}9 \times {\cdot}3605 \times 6{\cdot}31}{\pi \times ({\cdot}105)^2 \times 87{\cdot}45 \times 60}$$
$$= {\cdot}883 \text{ C.G.S. unit.}$$

This value is not corrected for the error given by the approximate formula already mentioned. Error:

$$= (V_1 - \theta)\frac{\frac{a}{2l}\frac{K}{k}\frac{b-a}{b}}{1+\frac{a}{2l}\frac{K}{k}\frac{b-a}{b}} \doteqdot {\cdot}69\text{deg. in this case.}$$

This makes the difference of temperature less by ·7deg., and when this correction is made we get for the conductivity ·889 C.G.S. unit. The conductivity as calculated from five different lengths becomes, after the correction is made—

Length in centimetres.	Conductivity.
6·31	·889
5·87	·893
5·23	·890
4·59	·887
4·015	·888

The greatest difference between these values is a little over 1 per cent. Taking their mean, we get for the thermal conductivity of the laboratory copper wire ·8884 C.G.S. unit. This value is the mean conductivity between the temperatures 97deg. C. and 10deg. C. The following table gives the results of a series of tests on another portion of the same wire:

Length in centimetres.	Conductivity.
6·11	·888
5·71	·883
4·80	·892
4·43	·889

The mean of these values is ·8880, being $\frac{1}{2\cdot3}$ per cent. less than that obtained from the preceding series.

Taking Angström's formula, $K = 1{\cdot}027\,(1 - {\cdot}00214\,t)$, and finding K for 53deg., which is the mean of 97deg. and 10deg., we get K = ·9208 C.G.S. unit.

The close agreement in the values obtained with different lengths shows that the errors already mentioned as possible are practically eliminated. Angström's value is 4·5 per cent. greater than ·8884, but, as has been mentioned, the conductivity of the laboratory copper wire is 8 per cent. less than that of Glover's wire afterwards tested. In a previous paper, Angström gives ·91 as the value for 51·3deg. C.

In a paper read before the Royal Society last year, Dr. R. W. Stewart, using the Forbes method, but substituting a single thermo-electric junction for the thermometers, gives the values for copper and iron. At the temperature 53deg. C. he gets for copper K = 1·067, which is 10 per cent. higher than the value obtained for any specimen of copper tested in the present investigation.

The conductivity of the wire obtained from Messrs. Glover and Son was found to be ·9594 C.G.S. This was the best conducting copper tested by the present method. The specific electrical resistance was 1,730 in absolute units. To test separately the effect of any alterations, separate experiments were made. Instead of enclosing the whole length of the wire (laboratory copper) in a tube, only a part was enclosed. The paper tube was shortened by 2mm. or 3mm. each time, and the conductivity of the same length of wire was determined after each shortening of the tube. The result found, was that the shortening (which was, of course, done from the cool end of the wire) had practically no effect on the value so long as it was arranged that there were no draughts of cold air. If for no other reason, the paper tube is necessary to prevent draughts, as the latter make a determination impossible. It was found that the paper tube could be shortened as much as to leave the lower half of the wire exposed without any appreciable diminution of the value obtained. When it was shortened much further the value began to diminish till, when the tube was removed altogether, the value obtained was found to be fully 6 per cent. lower than when the tube completely covered the wire. When the wire was bare it was found very difficult to prevent draughts caused by the hot wire, and these draughts made the readings of the thermometer very irregular. In connection with this it will be noted that there is a particular advantage in having the calorimeter ball lower in position than the heating-box, as the hot air round the latter rises, and so does not affect the water-jacket. It has been suggested, however, that a separate experiment should be made to test whether any heat

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reached the ball otherwise than through the wire. For this purpose the ball was suspended by silk threads in such a way that its highest point was 4·4 centimetres from the bottom of the heating-box. The water-jacket was placed round the ball, and the sheets of paper put on the top of the jacket. The water in the heating-box was kept boiling for 25 minutes, and the temperature of the ball, as indicated by the thermometer in it, was noted at intervals. No change in the thermometer reading could be detected, although $\frac{1}{10}$th of 1deg. can be read without difficulty on the thermometer scale.

As a further test of the effect of the paper tube, the upper half length of the wire which was being tested was left unprotected by any tube, while the lower half was enclosed. The result was practically the same as if there had been no tube at all.

In order to make certain that the thermometer in the hot water indicated the temperature of the upper end of the wire, a thermo-electric junction was used. The junction was made of very thin wires of copper and platinoid, and, after being wrapped once round the hot end of the wire just at the end, was soldered there. The other junction was fixed to a thermometer and immersed in water. The heating-box was then filled with water, which was kept boiling. The water in the vessel containing the other junction was gradually heated up till there was no deflection in the mirror galvanometer used. Both junctions must then be at the same temperature. When there was no deflection in the galvanometer the thermometers were found to be indicating the same temperatures.

Several qualities of copper were tested, the results of which are given below.

Copper wire, made by Messrs. Bolton and Co., Cheadle, was by mistake sent away before its electrical conductivity was measured, and it cannot be got again.

Length used (in centimetres).	Mean conductivity between 10deg. C. and 97deg. C.
7·0	·867
6·33	·862
5·7	·859
5·1	·858

The greatest variation here is 1 per cent., and the mean value is ·8612.

Some specimens of copper wire were bought in a plumber's shop of quality used for bell-hanging.

Specimen.	Diameter (in centimetres.)	Specific resistance (electrical).	Mean thermal conductivity.
1	·200	5545	·3198
2	·204	4701	·3497

$$\frac{\text{Conductivity of laboratory wire}}{\text{Conductivity of specimen 1}} = 2{\cdot}78 \text{ for heat;}$$

$$= 2{\cdot}86 \text{ for electricity.}$$

$$\frac{\text{Conductivity of laboratory wire}}{\text{Conductivity of specimen 2}} = 2{\cdot}54 \text{ for heat;}$$

$$= 2{\cdot}56 \text{ for electricity.}$$

$$\frac{\text{Conductivity of Glover's wire}}{\text{Conductivity of laboratory wire}} = 1{\cdot}08 \text{ for heat;}$$

$$= 1{\cdot}066 \text{ for electricity.}$$

In all the wires tested it was found that if one metal was a better conductor for electricity, it was also better for heat. This has been noticed by several investigators, notably Prof. Tait, and Wiedemann and Franz. Beyond this the present results cannot go, as enough trials were not made to allow of comparison. Previous experimenters have found that the ratio of electrical conductivities of two wires is not exactly equal to the ratio of thermal conductivities. This is indeed to be expected, if the coefficients already obtained for the alteration with temperature are accurate. For example, in copper the coefficient of variation per degree for electrical conductivity is very much greater than that found for thermal conductivity, so that, even if the ratios were equal at one temperature, they must be unequal at all other temperatures. In some of the wires tested the electrical and thermal ratios differed by as much as 4 or 5 per cent.

Before the present investigation, the absolute values for the conductivity of the more expensive metals had not been determined, although relative values had been found by Wiedemann and Franz. I am very much indebted to Messrs. Johnson, Matthey, and Co. for their great kindness in preparing and lending to me wires of gold, platinum, silver, and other pure metals, of 2mm. diameter, and of such a length as to enable me to measure without difficulty both the thermal and electrical conductivities.

Unfortunately, I cannot find a record of the value obtained for the electrical conductivity of the gold wire, and it has been returned some time ago. As, however, Messrs. Johnson, Matthey, and Co. stated when sending it that it was as pure as could be made, it will perhaps be sufficient for me to use the value that has already been found for the electrical conductivity of gold as determined by other experimenters.

The curves for the calculation of the conductivity of silver wire are shown in Diagram II. The values for the different lengths are given below.

Silver Wire.

Length.	Thermal conductivity in C.G.S. units between 15deg. C. and 98deg. C.
7·86	·956
6·59	·960
6·59	·963
5·61	·973

It will be observed that the second and third values, although for the same length, differ by about $\frac{1}{3}$ per cent. They are both given, however, as they agree within the limits of observational errors. The mean of these values is ·9628.

As the curves for gold and platinum are very similar to those for copper and silver, it may be enough to give the values obtained for their conductivities.

Gold Wire (not annealed). Diameter ·202cm.

Thermal conductivity in C.G.S. unit.	Electrical resistance as determined by Dr. Matthiessen.
·7464	2188

Comparing these values with those for Messrs. Glover's copper, which was found to be ·959, we find that the thermal conductivity of gold is 78 per cent., and the electrical conductivity 81·6 per cent. that of copper.

Platinum Wire (not annealed). Diameter = ·202cm.

Thermal conductivity.	Electrical resistance.
·1861	9180

Here the thermal and electrical conductivities are each 19 per cent. of the conductivity of copper.

The gold, platinum, and silver were afterwards carefully annealed by Messrs. Johnson, Matthey, and Co., and the conductivities again determined. In each of the cases the alteration due to annealing was less than 1 per cent. both in electrical and thermal conductivity.

The results for the different metals are therefore:

Mean Conductivity between Temperatures 10deg. C. and 97deg. C.

			Diameter. Millimetres.
Copper—Specimen	1	·9594	2·00
	2	·8884	2·11
	3	·8612	3·09
Very impure	4	·3497	2·04
	5	·3198	2·04
Silver		·9628	2·02
Gold		·7464	2·00
Platinum		·1861	2·00

It is intended to use other liquids than boiling water to heat one end of the wire, and in this way test the alteration of conductivity with temperature. Up to the present time no alloys have been tested, but it is intended that tests should be made of some, such as platinoid and German silver; also iron, as pure as possible, might be tested. Instead of boiling water, steam was used for some time in this investigation, and was in some respects found to be more convenient. Fig. 7 is a sketch showing a section through the middle of the apparatus. The steam is generated in the vessel, W, passes along the upper tube, T, in the direction of the arrows, and blows directly on the end of the wire, afterwards passing out through the outside copper tube, P, and escaping by the outlet, B. The thermometer, D, indicates the temperature of the steam just when it strikes the wire. It will be seen that the outer tube with the steam in it serves as a steam-jacket, and thus keeps the steam in the inner tube, T, at a high temperature. The sloping bottom, where the wire is fixed at A, is so

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made to prevent water accumulating there. To ensure that as much steam as will supply all the heat that the copper can take up is impinging at A, it is only necessary to arrange that the steam emerges at B as steam. The outside tube need not be more than 4cm. diameter, and may be round, but the part where the wire is soldered in must be thickened, and made as shown in the sketch, so that there may be no risk of water gathering above the wire. The length of the tube need not exceed 15cm. This allows sufficient length for the tube to be inserted into the screen, which prevents the heat of the lamp from altering the temperature of the ball. The diameter of the inside tube may be 1·5cm. With this apparatus the most satisfactory results were obtained.

When a metal is tested for the first time, it will be advisable to find its approximate thermal conductivity by comparing its electrical conductivity with copper. This will give an idea as to which calorimeter ball to use, and

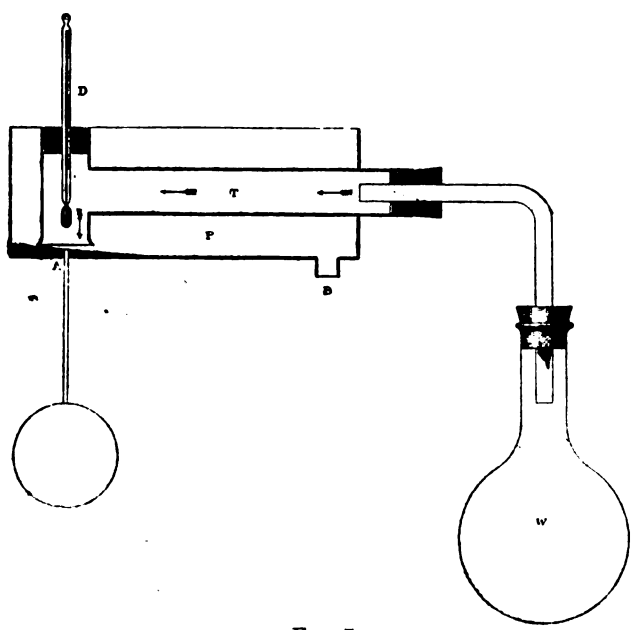

FIG. 7.

what length of wire will give a convenient rise of temperature per minute. A test is then almost as simple as for electrical conductivity.

THE THEORY OF ALTERNATING CURRENTS.—VII.

BY A.INST.E.E.

§ 21. **Alternating-Current Power.**—It is well known that the resistance of conductors dissipates energy, and that when a current of electricity flows through a conductor it can only do so at the expense of electrical energy, and the *rate* at which electrical energy is developed or dissipated is defined as electrical *power* or *activity*. When energy is utilised, *power* is the *rate* at which the E.M.F. does work, and we shall find in dealing with alternating-current power that once more we have to modify the general expression as stated for continuous currents. To determine the electrical power absorbed or developed in continuous-current circuits, we simply take the product and pressure of the amperage—that is

$$\text{power} = \text{pressure} \times \text{amperage} \quad . \quad . \quad (1)$$

or, $\quad W \text{ (watts)} = E \text{ (volts)} \times C \text{ amperes.}$

With alternating currents, however, the case is not quite so simple. As we have seen, the current and the E.M.F. pulsate at a rapid rate according to a periodic law, and it is evident that the power absorbed at one instant is not the same as that of the next; in other words, the rate of doing work varies from instant to instant. When induction is present in the circuit, the current, as we have seen, lags behind the E.M.F., and we shall find presently that the angle of lag is a most important factor as regards alternating-current power. To simplify matters, we shall state the expressions for alternating-current power in terms similar to those used in equation (1)—thus,

$$\text{alternating-current power} = \text{pressure} \times \text{amperage} \times K \quad (2)$$

in which K is a constant known as the *power factor*. The magnitude of the power factor varies according as we express the pressure and amperage in terms of the maximum or virtual values, and also whether the circuit under consideration is inductive or not. There are, therefore, two main cases to consider—*i.e.*, the determinations of the value of K for (1) non-inductive circuits and (2) inductive circuits.

§ 22. **Non-Inductive Circuits.**—In Fig. 17 is given the E.M.F. curve for a non-inductive circuit, together with the corresponding current curve. This may be considered as an example of a circuit consisting only of incandescent lamps, and it is evident from the conditions of the problem that

(1) There is no angle of lag; that is, the current curve is in phase with the E.M.F. curve.

(2) The ratios of the various lengths of the ordinates for the E.M.F. curve to the corresponding lengths of the ordinates for the current curve are numerically equal to the resistance of the circuit.

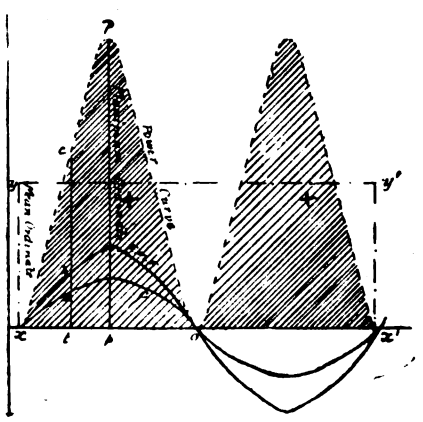

FIG. 17.

These curves give us the instantaneous values of the E.M.F. and the current for a complete period, and by multiplying together the two coincident ordinates for each division along the axis we get a series of values for the power corresponding to the instant denoted by the divisions. Thus, by multiplying the ordinate $t\,b$ by the ordinate $t\,a$, the values of the E.M.F. and the current at the instant denoted by the time t, we obtain the instantaneous value of the power at that particular point of the cycle, and by continuing this process we get a third curve by plotting the successive values of the products. This is shown as a dotted line, which with the axis encloses the shaded portion. Such a curve is designated the *power curve*, and it represents graphically the variation in the rate of dissipation of electrical energy from instant to instant.

It will be noticed that whilst the E.M.F. and current curves are below the axis, $x\,x^1$, for the second half of the period, as their directions are then negative, the corresponding power curve is placed above $x\,x^1$. The reason for this is plain. During the first half of the period the power curve is obtained by taking the product of two positive quantities, whilst in the latter half we have to multiply together two negative quantities, which, as is well known, gives a positive quantity. This result expresses a physical fact—*i.e.*, that such a circuit is always absorbing power. It is also important to notice that the sum of the areas enclosed by the power curves and the axis represents the total amount of work done during one period, since the portions shaded are, in area, equal to the product of the power and the time of one period. It will also be noticed that the power curves are perfectly symmetrical, and it can easily be proved that the sum of the two areas enclosed is equal to the area of the rectangle $x\,y$, y^1x^1, the height $x\,y$ or x^1y^1 being half the length of the maximum ordinate of the power curve.

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Since the maximum ordinate $P\,p = E_{max} \times C_{max}$

$$\therefore x\,y = \tfrac{1}{2}\,P\,p = \tfrac{1}{2} \times E_{max} \times C_{max};$$

but work done in one period = area of rectangle $x\,y\,y^1x^1$

$$= x\,y \times x\,x^1 = \tfrac{1}{2}P\,p \times x\,x^1$$

$$= (\tfrac{1}{2} \times E_{max} \times C_{max}) \times x\,x^1$$

and power is rate of doing work

$$= \frac{\text{work done}}{\text{time taken}} = \frac{(\tfrac{1}{2} \times E_{max} \times C_{max}) \times x x^1}{x\,x^1}$$

or, $$\text{mean power} = \tfrac{1}{2} \times E_{max} \times C_{max} \quad . \quad . \quad (3)$$

This expression corresponds to equation (2), and $K = \frac{1}{2}$; and we see that when the maximum values of the E.M.F. and the current are stated with non-inductive circuits, the rate of the development or dissipation of electrical energy is given by the product of the maximum values multiplied by $\frac{1}{2}$.

Again, since $\frac{1}{2} \times E_{max} \times C_{max} = \frac{E_{max}}{\sqrt{2}} \times \frac{C_{max}}{\sqrt{2}}$,

$$\therefore \text{ mean power} = \frac{E_{max}}{\sqrt{2}} \times \frac{C_{max}}{\sqrt{2}} = E_{virt} \times C_{virt} \quad (4)$$

$$= (\sqrt{\text{mean square}}\ \text{volts}) \times (\sqrt{\text{mean square}}\ \text{amperes}).$$

In this form we see that the *power factor*, or K = 1; and it is evident that to get the value of the mean power of a non-inductive circuit, it is sufficient to take the product of the $\sqrt{\text{mean square}}$ values as given by a Cardew voltmeter in the one case and a Siemens dynamometer, say, in the other. Thus, the process of determining the watts expended in lighting an incandescent lamp is the same for alternating currents as for continuous currents, since the power factor in each case is unity, only suitable instruments must be used.

§ 23. **Inductive Circuits.**—When a circuit contains inductance as well as resistance the determination of the mean power is not quite so simple as the one just considered. The fact that the current lags behind the E.M.F. is well known, and it is evident that the product of the $\sqrt{\text{mean square}}$ values will not give the value of the mean power, since the $\sqrt{\text{mean square}}$ value of the pressure ordinate is not coincident with the $\sqrt{\text{mean square}}$ value of the current. The problem under consideration is given in Fig. 18,

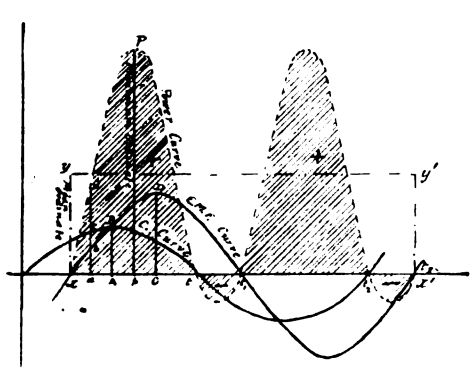

Fig. 18.

and for the purpose of comparison the magnitudes of the E.M.F. and the current are the same as in the previous case, and it will be noticed that the current is retarded behind the E.M.F. 45deg.

As in the previous case the *power curve* is plotted from the series of the instantaneous values of the power for a large number of points during a period, obtained by multiplying together the lengths of the corresponding ordinates; thus the height of the ordinate $a\ d$ is equal to the product of the heights of the ordinates $a\ b$ and $a\ c$. It is important to notice in this case that the power curve is wavy, and includes two portions below the axis $x\,x_1$. These are marked negative, since for the portions of the period indicated by the lengths, $t\,t_1$ and $t_2\,t_3$, on the axis, one of the factors—the E.M.F.—is negative in direction, whilst the current is still positive. The meaning of this is that the sum of the two areas below the axis must be deducted from the sum of the areas above the axis to give the total amount of work done during the period, from which it is plain that the height, $x\,y$, of the rectangle, $x\,y$, $x'\,y'$, will not be $\frac{1}{2}\,P\,p$, if it is to give an area equal to the amount of work actually done during the period. It can, however, be easily proved that $x\,y$ is equal to half the product of A B and C D—the maximum values of the E.M.F. and current—multiplied by the cosine of the angle of lag. That is,

$$x\,y = \tfrac{1}{2} \times A\,B \times C\,D \times \cos\theta = \tfrac{1}{2} \times E_{max} \times C_{max} \times \cos\theta;$$

where θ = is the difference of phase, or angle of lag. Since $x\,x^1$ is time, and the area $x\,y$, $y'\,x'$ measures work, therefore $x\,y$ measures *power*, or the rate of doing work;

$$\therefore \text{ mean power} = \tfrac{1}{2} \times E_{max} \times C_{max} \times \cos\theta \quad . \quad (5)$$

and the *power factor* for an inductive circuit, when the maximum values are given, is $K = \frac{1}{2}\cos\theta$.

$$\text{But } \tfrac{1}{2} \times E_{max} \times C_{max} \times \cos\theta = \frac{E_{max}}{\sqrt{2}} \times \frac{C_{max}}{\sqrt{2}} \times \cos\theta$$

$$= E_{virt} \times C_{virt} \times \cos\theta$$

$$\therefore \text{ mean power} = E_{virt} \times C_{virt} \times \cos\theta \quad (6)$$

from which we see that K, the power factor, is equal to the cosine of the angle of lag. But the cosine of an angle varies between unity and zero—that is, K has for its limiting values 1 and 0. The former is the case of the non-inductive circuit of § 22, whilst the other limit is reached when the angle of lag is 90deg. Such a case is represented by Fig. 19, which will be understood without further explanation, it being noticed that the total area is zero, from which it is evident that the rate of doing work is zero.

Between these two limiting values the magnitude of K will be a fraction, showing that the power as given by equation (6), which are termed *true watts*, is less than the product of the $\sqrt{\text{mean square}}$ volts and the $\sqrt{\text{mean square}}$ amperes, which are termed the *apparent watts*. The ratio between these two quantities, or $\frac{\textit{true watts}}{\textit{apparent watts}}$, is termed the *power factor*, which we have represented by K throughout this paper.

At this point it will be interesting and instructive to notice an example which has an important application in

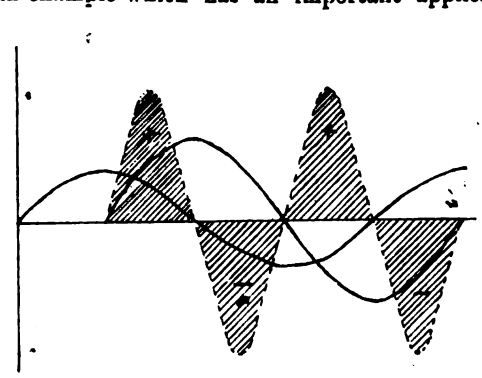

Fig. 19.

practice. Most meters used for recording Board of Trade units supplied to a circuit simply measure the ampere-hours, and assuming that the pressure between the mains is kept constant, the meters may be calibrated to record the expenditure of energy. But it is plain that a circuit may contain (1) resistance only or (2) resistance combined with inductance, and still the same current to flow under the same pressure, in which cases a meter will indicate the same consumption of energy in each case, whilst from equations (4) and (6) it is evident that the actual amount of energy is different in the two cases. This means that a consumer would be paying for more units than he has received, according to the readings of the meter.

We shall collect the various expressions for power which have been determined above, so that we may see at a glance the variations in the value of the power factor, K.

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For continuous currents:

$$\text{Power} = C \times E.$$

For alternating currents:

$$\text{Mean power} = \text{pressure} \times \text{amperage} \times K;$$

$$\left.\begin{aligned} &= \tfrac{1}{2} \times E_{max} \times C_{max} \\ &= E_{virt} \times C_{virt} \end{aligned}\right\} \text{non-inductive circuits;}$$

$$\left.\begin{aligned} &= \tfrac{1}{2} \times E_{max} \times C_{max} \\ &= E_{virt} \times C_{virt} \times \cos\theta \end{aligned}\right\} \text{inductive circuits.}$$

THE TESTING OF ALTERNATING-CURRENT DYNAMOS.*

BY H. BEHN-ESCHENBURG.

As is well known, that quantity which most surely determines the value and efficiency of an alternating-current dynamo is the fall of potential—*i.e.*, the difference in the potentials at the terminals of the dynamo, 1deg., when no current flows through the armature, and 2deg., when the armature windings generate a current which has a definite difference of phase with the terminal potential, the revolutions and the current in the magnetising field being constant in both cases. In other words, the fall of potential is the difference in the potentials (with constant excitation and revolutions) at no load and at a certain definite load. This fall of potential is determined essentially 1deg., by the reaction of the "current-carrying" armature windings on themselves; 2deg., by the copper resistance of these windings; and 3deg., by the reaction of the Foucault currents induced by the armature currents, principally in the massive iron field magnets.

These determining factors of the fall of potential may be represented as E.M.F.'s which, in definite phase, combine with the E.M.F. of the dynamo to form the resultant terminal potential.

We thus obtain three E.M.F.'s in the armature windings, proportional to the currents in the armature, which we place in a polar diagram, Fig. 1, according to their effective values and their phases—*i.e.*, their directions—and designate by e_1, e_2, e_3.

In the same diagram we let I represent the armature current (*i.e.*, the load current of the dynamo); E, the E.M.F. of the dynamo, which is equal to the terminal potential difference at no load; and E_1, the terminal potential difference when loaded. The direction of the different quantities is determined by the angle of the phase difference which they have relatively to the current, I. There will now naturally be a phase difference of $\frac{\pi}{2}$ between the E.M.F., e, of the self-induction and the current; and between the E.M.F.'s e_1 and e_3 and that of the current a phase difference of 0. We assume, further, that for the chosen load of the dynamo the phase difference between the terminal potential difference and the current is ϕ, where ϕ is defined by making the delivery in watts of the dynamo $W = E_1 I \cos\phi$.

For lighting distribution with transformers, ϕ is about 10deg. and cos ϕ practically equal to 1; and for power distribution with non-synchronous motors ϕ may be taken as about 35deg. and cos ϕ about 0·85. The fall of potential of the dynamo, taken from the diagram, equals $E - E_1$.

For synchronous motors the same diagram is to be employed when the E.M.F. of the synchronous motor is greater than the terminal potential difference; if, however, $E = E_1$, e is to be drawn in the opposite direction.

The resultant, e of the three E.M.F.'s, e_1, e_2, and e_3, in a phase α relative to I, represents the total counter E.M.F. of the "current-carrying" armature. By this E.M.F. e, and the current I, and apparent resistance of the armature windings is defined as

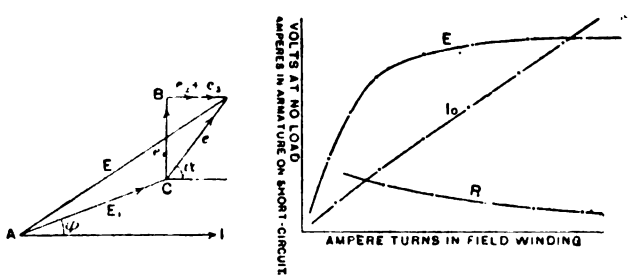
$$R = \frac{e}{I}.$$

A chief problem in the testing of alternating-current dynamos is to ascertain and calculate in advance this resistance, R and e, as when they are known all quantities important for operating may be taken directly from the diagram, Fig. 1.

For this purpose I have for some time taken the following course, which I most heartily recommend to my colleagues. In the first place, there is drawn in the ordinary manner a characteristic of the E.M.F. of the dynamo when no current flows in the armature (compare Fig. 2, Curve E). The abscissæ are the number of ampere-turns of the magnetising continuous current—that is, the strength of the exciting current—and the ordinates are the induced E.M.F.'s, E, of the dynamo at a fixed number of revolutions. A second characteristic, I_0, is taken after the armature windings have been short-circuited by an ammeter across their terminals. The abscissæ are again the number of ampere-turns of the field, and the ordinates are the current strengths of the short-circuited armature in amperes (designated by I_0). This curve I_0 as a rule, differs but slightly from a straight line; with strong fields it is a little convex.

For the case of the short-circuited armature, the diagram, Fig. 1, is to be changed so that $E_1 = 0$, $E = e$, and we then immediately obtain in Fig. 3, $e = E$, and $R = \frac{E}{I_0}$ for every value of the abscissæ.

This value of R we place as ordinates in Fig. 2, and so form a third characteristic, R, of the apparent resistance for every value of the field strength.



FIGS. 1 AND 2.

For any value of the load current, I, with a fixed field excitation, $e = R I$ is given directly, and E_1, and ϕ may be calculated from the diagram. With a given field current, either E, ϕ, and I are to be assumed as given and E_1 is to be determined in advance, or E, E_1, and I are given or observed and ϕ is to be determined from them. The following formulæ result from the oblique-angled triangle, A B C, of the diagram:

$$\cos(\alpha - \phi) = \frac{E^2 - E_1^2 - e^2}{2 E_1 e};$$

$$E_1 = E - e\cos(\alpha - \phi) - \tfrac{1}{2}\frac{[e \sin(\alpha - \phi)]^2}{E}.$$

(The counter E.M.F., e, should naturally be considerably smaller than E in practical cases.)

Finally, in order to ascertain the difference of phase α between e and I_0 or I, we must observe not only the current I_0 with short-circuited armature, but also the watts consumed, $E I_0 \cos\alpha$, either directly by means of a watt-meter, or by measuring the expenditure of energy necessary to drive the short-circuited dynamo; this last may be done by observing the watts used by a continuous-current motor employed to drive the alternator. With good dynamo machines, α is greater than 80deg., and for approximate measurements may be put equal to $\frac{\pi}{2}$. This means that the copper losses and the losses through Foucault currents should be very small compared with the losses in potential. The component e_2 of the E.M.F. e is easily determined by means of resistance measurements, for if r be the armature resistance, $e_2 = I r$.

The component e_3 increases approximately with the square of the number of revolutions, and so can be separated from e_2. As a check, α can be calculated when measurements with the dynamo loaded have given observed value of E_1, E, I, and ϕ; for instance, when $\phi = 0$, or $\phi = \frac{\pi}{2}$, with wholly inductionless or purely inductive load

* From the *Electrical World* (New York).

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respectively, or when ϕ is determined by means of a wattmeter.

(It is to be remarked that for small values of ϕ, for instance, with transformers, the diagram will give much more accurate determinations than a wattmeter, for from the diagrams in ϕ and from the wattmeter cos ϕ is read.)

If, as an approximation, we make $\alpha = 90$deg., the formulæ for ϕ and E will become simplified, as follows:

$$\sin \phi = \frac{E^2 - E_1^2 - e^2}{2 E_1 e};$$

$$E_1 = E - e \sin \phi - \frac{e^2 \cos^2 \phi}{2 E};$$

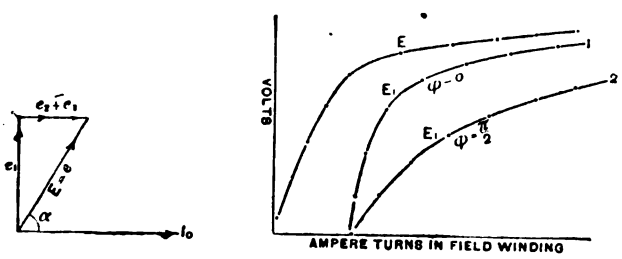
and for the limiting cases of inductionless and purely inductive load:

$$\phi = 0; \qquad E_1^2 = E^2 - e^2;$$

$$\phi = 90\text{deg.}; \quad E_1 = E - e.$$

The two characteristics, E and I_0, may be taken in a very short time with a voltmeter, a continuous-current ammeter, a speed-counter, and an alternating-current ammeter. The dynamo requires in this case only 10 to 20 per cent. of the normal power to drive it—*i.e.*, the energy loss of the loaded dynamo.

The short-circuit current, I_0, during the short time which is necessary for the observation, may be raised without



FIGS. 3 AND 4.

hesitation to two or three times the normal current. When taking the short-circuit curve, I_0, the number of revolutions are of small importance, for with a fixed field magnetisation the short-circuit current will naturally remain constant at all speeds.

In the curve diagram, Fig. 4, are drawn the special characteristic curves of the terminal potential, E_1, calculated from Figs. 1 and 2, which correspond to the dynamo load when carrying a current I in the two limiting cases $\phi = 0$ and $\phi = 90$deg., for all field excitations and $\alpha = \frac{\pi}{2}$. These are the curves 1 and 2, between which, for all possible value of ϕ, must be the terminal potentials of the dynamo with the current I.

Besides the quantity, R, determining the efficiency of the dynamos, this method gives a clear picture of the leakage conditions of the machine. The ampere-turns of the "current-carrying" armature windings must act inductively on the same magnetic circuit; the lines of force which are induced by one of these windings without cutting the turns of the other, are designated as scattered lines.

We will assume that $100 \times S_1$ per cent. of the total lines induced by the field winding and $100 \times S_2$ per cent. of the total lines of the armature winding are scattered, and so lost for useful inductive working.

Let the number of turns of the field be w_1, and of the armature w_2, in which both numbers are to be reduced to the same magnetic circuit. This reduction is easily accomplished by the help of a systematic drawing, in which the magnetic circuit—that is, the closed courses of the magnetic lines of force in the dynamo—are drawn as linear conducting circuits, in analogy to the diagram for branching electric currents, and the ampere-turns of the armature and the field, at the places where the windings are cut by the circuit of the lines of force, are designated as magnetomotive forces, analogously to E.M.F.'s. The number of lines of force, in analogy to a current strength, is calculated for every part of the circuit according to Kirchhoff's rules for divided currents. For the short-circuit, equality must obtain between the magnetomotive forces of the armature current and the field current as far as the ampere-turns which occasion the scattered induction and those which induce the E.M.F.'s e_2 and e_3. These equal ones are the magnetomotive forces which induce the E.M.F.'s E and e_1.

We thus obtain the important condition:

$$(1 - S_1)\, i_0 w_1 = \frac{1{\cdot}4\,(1 + S_2)\, I_0 w_2}{\sin \alpha},$$

in which i_0 is the continuous field current, and the factor 1·4 in the right member the amplitude of the mean value of I_0.

If the field system possess a single magnetising coil, w_1, as is easily seen, must be multiplied by half the number of poles; and if the armature system consist of N phase divisions, w_2, in the right-hand member, is to be multiplied by $\frac{N}{2}$, and w_2 signifies the number of turns of one phase division.

From this equation, which besides the number of turns presupposes only the observation of the Curve I_0, we obtain for every excitation of field the value of the loss of potential in per cent.—that is, the value of the ratio of the counter E.M.F. e to the E.M.F. E_1 of the dynamo with a load current I:

$$\frac{e}{E} = \frac{I}{I}; \text{ or, also, } \frac{e}{E} = \frac{I w_2}{i_0 w_1} \cdot \frac{1{\cdot}4\,(1 + S_2)}{(1 - S_1) \sin \alpha}.$$

That is to say, e has the same ratio to E as the load current has to the short-circuit current, with constant excitation; or, as the number of ampere-turns of the armature to those of the field, multiplied by a factor approximately equal to 1·4. This factor is:

$$\frac{1{\cdot}4\,(1 + S_2)}{(1 - S_1) \sin \alpha} = \frac{i_0 w_1}{I_0 w_2}.$$

The leakage value, S, is, on the other hand, easy to calculate when the principal dimensions are known, so that the preceding formula will give the value of S_2, which is difficult to calculate. The total magnetic resistance, ρ, of the magnetic circuit of the field and armature winding is calculated in the usual manner from the individual resistances of the air-gaps and the iron parts at the chosen saturations.

If we designate the total number of lines induced by the ampere-turns of the field by $\mathfrak{B}$, and the number of alternations of the dynamo by n, the well-known equations obtain:

$$E = \frac{\mathfrak{B} \cdot w_2 \cdot 2\pi n}{1{\cdot}4 \times 10^8} \frac{4\pi}{10} i_0 w_1 = \mathfrak{B} \rho\,(1 + S_1).$$

Also,
$$1 + S_1 = \frac{5{\cdot}6\, i_0 w_1 w_2 n}{E \rho\, 10^8}.$$

On the other hand, in the case of the short-circuit:

$$I_0 R = E, \text{ and } R = \frac{8 w_2^2 n\,(1 + S_2)}{\rho\,(1 + S_1)\,(1 - S_1) \sin \alpha\, 10^8}$$

This last equation shows us the constructive meaning of the apparent resistance, R, of the dynamo. R increases proportionally to n, and with the square of the number of turns.

By means of this sketch I believe that I have shown a very convenient method, which I have myself tested in a number of practical cases, giving direct values which make possible an exact and unobjectionable comparison and discussion of alternators. Knowing the characteristics for no load and for short-circuit, the limits of the loading of every dynamo for a prescribed terminal potential difference can be determined beforehand; that is, the values of the current strength and of the shifting of phase between the current and the terminal potential.

Annual Outing.—The employés of the Electrical Company, Limited, 122 and 124, Charing Cross-road, and the Calmon Asbestos and Rubber Works, British Agency, of the same address, together with a few guests, under the congenial leadership of their managing director, Mr. F. T. Eggers, held their second annual outing on Tuesday, the 16th inst., when a most enjoyable day was spent.

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THAT "RARA AVIS"—A NEW COMPANY.

Our gaseous contemporary is sarcastic in the following manner: "At last there is news of another electric lighting company being brought before the public, and the event is of sufficient rarity to call for notice on this account. When things are very scarce—like great auk's eggs—they have a certain notoriety for this reason alone, irrespective of their intrinsic value or interest. So it is nowadays with new electric lighting companies. There was a time when these ventures were hatched out at the rate of two or three a week. But those days are gone, never to return. 'There are no eggs in last year's nests,' says the Spanish proverb. Therefore, when one hears of an announcement that the British public are again asked to put money into an electric lighting company, one wonders why the promoters are not content to do as electric lighting schemers generally have done for several years past—get their money out of the ratepayers."

We venture to think that our contemporary is seldom fair, and in this particular instance is cynically unfair. It knows that the said company or proposed company has met with no sympathy from the electrical technical Press—in fact, not only that it has met with no sympathy, but has by one electrical paper been soundly "slated." The *Journal of Gaslighting, etc.*, however, always shows an excessive eagerness where electric lighting is concerned to try to make black appear white. A red rag in front of a bull is a tamely inflammatory proceeding to the mention of electricity to the *Journal*. The former inflames the beast to a natural fury; the latter unhinges every spark of logic or argument. It seems to us that our contemporary works systematically to find bad points in electrical works, and refuses with the blindness of the man who will not see to acknowledge any good points. We are not very much concerned about how our contemporary conducts its crusade, because we conceive it has chosen the worst possible course, and every week, because of their very ostensible virulence, damns its own criticisms to all thinking men. It is perhaps unfortunate, however, that the world contains a large number of unthinking people who believe what they are told. In the hurly-burly of everyday life it is too much trouble to enquire as to the correctness of a statement, and we are often told that giving a "lie" twenty-four hours' start means impossibility in overtaking and correcting it. Now, a few plain words in connection with electrical companies may not be out of place. There exists a class of men called "company promoters," whose livelihood is derived by a due use of their brains and a thorough belief in Carlyle's view of mankind—that they are "mostly fools." Ninety-nine per cent. of the companies brought before the public are the result of company-promoters' actions—that is, so far as electricity is concerned, the action of men who have no technical knowledge whatsoever; who care nothing for the future of a company or the value of its assets; whose every care, in fact, is promotion-money, founders' shares, and Stock Exchange quotations. These men generally exploit patents, and for these

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patents can obtain satisfactory sentences in reports —from those who know and those who don't know— for satisfactory payment. A class of reports of the most annoying character during the last fifteen years has come from professors. The reports are in a sense true, but from a practical point of view are about as misleading as can possibly be devised. Prof. Optimistic has a patent put before him, and pockets a large fee to give a report. He does not deem it his duty to enquire into the purpose for which the report is to be used, and from his laboratory standpoint examines into the matter. This is all very good in its way, but, like too much plum pudding, requires a corrective, and the corrective ought to be applied by the practical man, who generally, as soon as he is asked to look into the matter, says it is not worth a damn. The exploiters flood the country with selected quotations, and pocket the sovereigns as they roll in. That is good business; and, so far as we are concerned, if fools will part with their money it is not our business to sympathise with the loss. We contend that the moral to be drawn from this company-mongering is, when a likely industry is started, clever City men see their opportunity of making money and they make it. First, they must have a good solid foundation to work upon. In electrical development they had it, and they ran it for all it was worth, till electrical company-mongering stank in the nostrils of the public. Another string to the bow of the company-mongers has been the promotion and exploitation of provisional orders. The success of gas monopolies underlay this action. It was early seen that under ordinary circumstances two or more electrical companies could not run side by side in one town, and there being in those early days hesitation for municipal authorities to take the plunge, the 'mongers thought to have a good time. The measure of success in this direction was not great, hence a diminution in the initiation of these companies. With the exception of that portion of the technical Press which is run by and on the behalf of company-mongers and trade cliques, there has been no hesitation in decrying these attempts to obtain money. It may be taken for granted that the exploitation of patents and the exploitation of provisional orders hardly present any inducement to company promotion at the present time. There are a few spasmodic attempts, at longer and longer intervals, to form a company in these directions, and the attempt decried by our contemporary is one such. It will be gathered from the foregoing remarks that, so far from looking upon the laxity of such company formation as an evil, we think it is an unmixed good. Once more we say that the previous attempts to run companies were made because clever City men saw that electrical work was sound. The work is now being carried out upon better business lines than by speculative company formation. The people who want the work done are now the people who are having it done and finding the money, instead of allowing outside people to exploit schemes for the sole purpose of adding exploitation costs to required capital. There is a vast difference in having work done because experience shows you want it, as against having it done because someone else says you want it.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE FIRE AT THE SALFORD WORKS.

SIR,—As a report has appeared in the Press of a fire which occurred on last Saturday night at our works at Salford, may we avail ourselves of your columns to inform you and our many friends and customers that only one department of our business was affected, and that all work is being carried on as usual and without delay?—Yours, etc.,

W. T. GLOVER AND CO.

Westminster, S.W., July 17, 1895.

THE ANNUAL MEETING OF THE VERBAND DEUTSCHER ELEKTROTECHNIKER AT MUNICH.

(BY OUR SPECIAL CORRESPONDENT.)

(Continued from page 35.)

FRIDAY, JULY 5.

The afternoon meeting in the Museumssaal, Promenadestrasse, was well attended, in spite of the wetting so many members had undergone while listening to the speeches which followed the unveiling of Ohm's statue. I noted, however, that many appeared in evening dress, which showed that I was not the only one wet through. The papers read in the afternoon included one on the Munich electricity works, by Herr F. Uppenborn. The diagrams round the walls fully explained the methods of street-lighting used in the town, and the design of the generating station. The arc lamps are in most cases suspended in the centre of the street at a height of about 33ft. above the roadway. The weight of the lamp is taken by a steel wire attached to the houses at either side. A pulley in the centre of this wire carries the wire by which the lamp is hoisted into position, and which, after passing horizontally to the house at one side, is led down to a rachet wheel on the wall. The conducting wires follow the same course. The lamp in being lowered describes the arc of a circle till a position is reached from which it can be conveniently trimmed from the footpath. The many ingenious devices which Mr. Uppenborn has got out in connection with these arc lamp suspensions will be more fully described when I get the promised drawings of them. The lighting effect of the lamp so suspended is exceedingly good, as there is no shadow cast on the street. At night it is difficult to see even how the lamps are suspended until late, when every alternate lamp is extinguished. In large public squares, where this method of suspension is not required, a number of arc lamps (three to five) are placed on masts at intervals in the centre, and then single arc lights on ordinary lamp-posts are used round the outside of the open spaces to be lighted. In all cases the lamps are lowered to be trimmed. The circuits are so arranged that alternate lamps can be extinguished to economise power after the busy periods of the night are passed. The rest of the details as to the central-station voltage, etc., will be given later, after the papers have appeared in the official organ of the society.

Another interesting feature in the afternoon sitting was the paper by Dr. W. Wedding on "The Comparative Studies of the Lighting Values of Acetylene, Gas, and Electricity." The last paper of the sitting was, it appears, specially arranged for the benefit of the ladies. It was by Herr Paul Stotz on electric cooking apparatus. A large number of the lady members of the Munich meeting flocked in and waited impatiently while the scientific part of the paper was read. The principle of the construction of the apparatus on view was the employment of a thin tissue of high-resistance alloys woven in an asbestos core. The string

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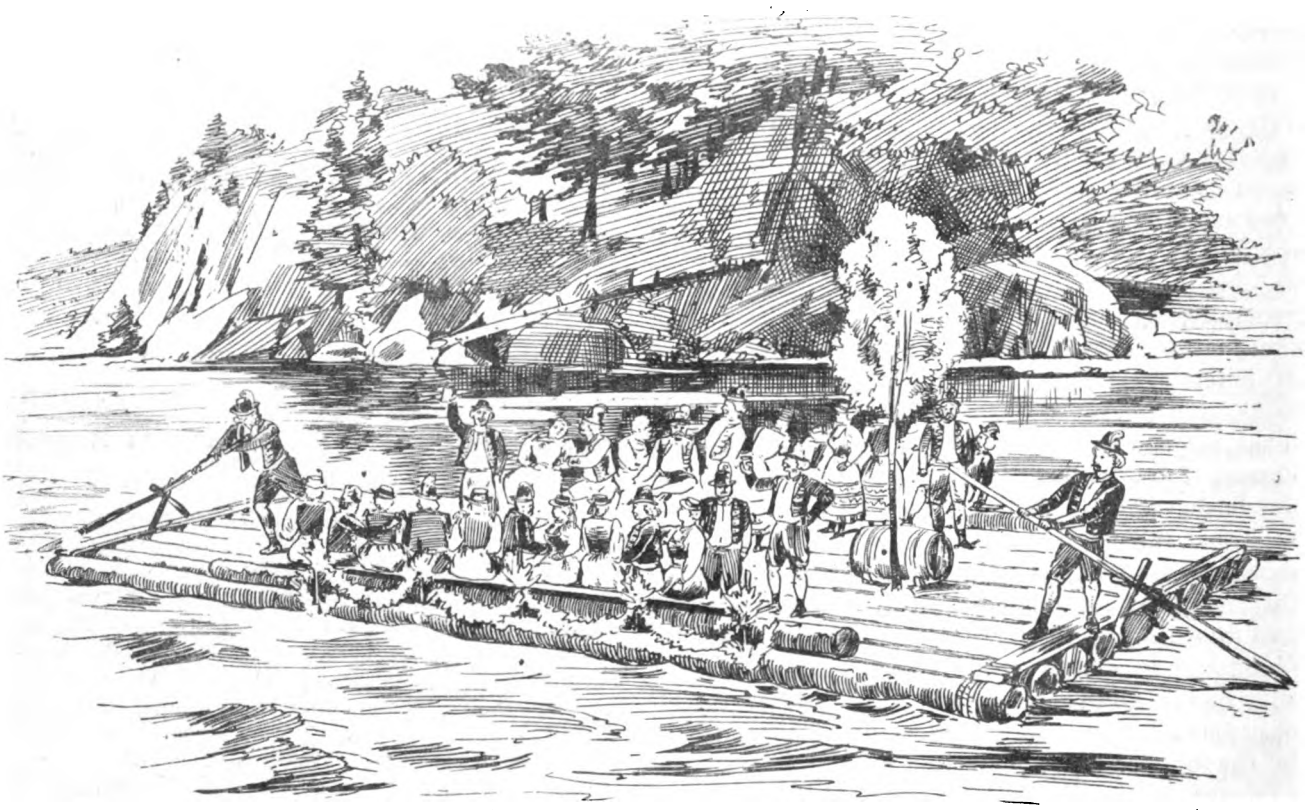
thus formed was coiled in spirals round the bottom of the various heating appliances. Personally, I prefer the construction of resistance in enamel, as made in England. Immediately the paper was read and the demonstration of cooking began, the ladies stormed the platform and critically examined the apparatus and the products from the various grills, etc. Sections of sausages which had been branded by the hot resistance cores were handed round. I gathered that one advantage of the beefsteaks cooked on the grill was that you could use them for chess-boards if the marks left by the resistance cores were only sufficiently numerous and rectangular. The distinctness of the marks left was never in question, but the ladies seemed to doubt that so much local heat was good.



Descending the Isar on Rafts.

At six p.m. the same evening we met again for "Fest-Mahl," commemorating the third annual meeting of the Verband Deutscher Elektrotechniker. This was held in the old "Rathhaussaal," or town hall, of Munich. The large hall in itself was most interesting from the array of carved woodwork, coats-of-arms, and flags which it contained.

Badge of Membership.

No specified seats were assigned to members who did not receive places at the chief table, but I was fortunate to receive an invitation from Mr. F. Drexler to join the Vienna party. This gentleman, who is the representative of the noted Oerlikon firm at the Austrian capital, introduced me to many of his friends who, like himself, could speak English fluently, so that I was able to gain much valuable lore in the German art of dining. The menu was a typical German one, and the toasts were taken between the courses. This method is good for digestion, though it made the dinner of seven courses spin out over three hours.

At the commencement of the dinner, memorial beer-jugs were placed to each guest. This jug, of which an illustration is given, is a production worthy of both the art and the beer of Munich. The handle of the lid is fashioned to represent the tower of the cathedral, and in the centre of the lid there is a copper electro of the badge of membership. The figure on the jug is the "München Kinder" of the legend. I enquired from my left-hand neighbour what the child of Munich did with his book, but a technical subject claimed our attention at that instant, and the legend was not forthcoming. The beer itself did not long hold out under the repeated toasts

Memento of the Verband Meeting in Munich.

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and the custom of clinking glasses with everyone within walking distance. It was very amusing to a stranger to the custom like myself to see an amiable doctor-professor come smiling down the room to clink glasses and utter the mystical term "Prosit" with a group of old friends. The custom also gave me many introductions, and before leaving the room my circle of acquaintances had increased threefold. It would be a valuable addition to some of the corporation festivals, where a trot round the table between courses would do a vast amount of good. The speeches were numerous but short and to the point, and after the various toasts the "Hochs" would have done credit to the breaking-up day of a public school.

Amongst those to whom I was introduced was Dr. Hermann Aron, the originator of the meter of that name. At this dinner the lady members appeared in full force, and throughout the whole of the meetings shared the enjoyment provided by the Munich committee.

The toast list was as follows: "The Kaiser and the Prince Regent of Bavaria," proposed by the Chairman, Prof. Dr. A. Slaby; "München," by Prof. Budde; "Electrical Engineers," by Bürgermeister Borscht; "The Verband," by Geheimrath v. Pettenkofer; "Herr v. Pettenkofer," by Herr Oskar von Miller; "Sculptors of the Ohm Statue—v. Ruemann and Thiersch," by Prof. Sonke; "The Ladies," by Herr F. Ross.

Saturday, July 6.

The papers to be read this morning were some of the most important of the interesting collection provided for the Munich gathering. The previous facilities for getting through the business were not considered sufficient, so an additional room was provided at the further end of a long gallery. The *modus operandi* then was as follows: Mr. G. Hummel read his paper on "Electric Meters" in the large room, and then, while the interested members were examining the models and diagrams, the others passed through into the other room to hear a paper by Dr. F. Ross on the Dubiau boiler. The arrangement was, in electrical terms, a two-phase system with currents at right angles. The one thus reached its maximum value while the other was at zero. There was, however, a conductor joining the two circuits whose impedance tended to perceptibly reduce the currents in either circuit. The conductor, or gallery, in question consisted of a combination of a small resistance and a large amount of self and mutual induction, which reacted on the capacity of the members. In other words, the refreshments temptingly displayed in the gallery prevented many members from reaching their destination when they were passing from one room to the other.

The paper on the Dubiau boiler was listened to with great attention, and by the kindness of the author I shall shortly be able to give the particulars and the illustration. The next item was by Dr. G. Roessler, of Berlin, on the effects of the wave form of alternating currents on the efficiency of a transformer. The conclusion arrived at by the author, from practical testing confirmed by mathematical reasoning, was that the iron loss in transformers is much less when currents with curves having irregular and peaked forms are used than with regular-shaped curves. The experiments were a continuation of similar investigations on the effect of the curves on the light-giving properties of an arc by Dr. Wedding and the same author; and it is curious to notice that what is bad for arc lamps is good for transformers, and *vice versâ*. There was not time at the meeting to go deeply into the reasoning and the methods of making the test, but I am much surprised at the conclusions arrived at. One naturally would expect the peaked curve to give highest maximum inductions, and hence greatest loss.

After a few more contributions to our scientific knowledge the indoor business of the session closed, and we commenced the excursion to view different works. By the aid of the electric tramway we proceeded to a railway station on the outskirts of the town. One noticeable feature in the Munich tram system is that most of the cars are open, with the exception of an awning, the seats being placed transversely. The trams are not stopped except at the principal street corners; at other places the passengers, including ladies, leave and join the car while it is in motion. The electric cars are not as yet running except on one or two sections, and the increased speeds of these may prevent open cars being so much employed. From the rail we proceeded to an intermediate station on our way to the Isar works and partook of an excellent lunch at a restaurant in the woods. Some worthy youth kept firing off a small cannon in our honour at irregular intervals. The effect on one's nerves was not pleasant, and the wish that the gun might burst was freely expressed. After lunch, we went on by special train to a station on the banks above the Isar works and walked down to them through most lovely woods. I leave the description of the works themselves till last, and will only chronicle my ideas. Firstly, the River Isar is quite unlike any river we have in England. It is always in a great hurry to get to the Danube, and the average speed of its water is at least eight miles an hour. Again, the quantity of water in the main channel is not perceptibly affected by the power works as far as I could see, and at the dam we visited on Saturday the quantity passing over the weir was enormously greater than that going into the head race. Locks are not used, but broad water shoots are left for the descent of rafts, etc. We visitors, after having the waterworks described, proceeded to the power-house. The general appearance of the interior of this does great credit to all concerned. Mr. Oskar von Miller explained to us the electrical details, though the construction of the large three-phase alternators required no explanation to me, as one was standing and could be freely examined. After enjoying a cup of electrically-boiled coffee, we proceeded to get aboard four timber rafts which were waiting in the tailrace to take us down the river. The rafts are beyond description in a paper debarred from the use of coloured illustrations. Their construction was simple: a number of rough tree-trunks, about 40ft. long, were fastened together at either end, and the space of 10ft. at each end was taken up for the steersmen. In the centre two logs were placed, about 2ft. above the others, at either side, and boards on these formed seats for our party. A silver-beech tree in the front marked the refreshment department, where the liberality of the Isar works directors was dispensed in the shape of "München bier" and sandwiches. The sides were decorated with green fir boughs. In the second raft the band was placed, so that at first we glided slowly down the tailrace enjoying sweet music. When, however, the main stream was reached the rafts assumed open order, and we, as the last raft, lost sight of those in front. The pace was most exhilarating, but when we approached the next weir I noticed that standing room on the seats was at a great premium. Our leading steersman, after assuring himself that our bark was going straight for the shoot, fastened up his large sweep, and came back into the body of the raft. We entered the shoot, and for an instant glided swiftly and smoothly down the rapid incline. Then came the broken water at the foot of the shoot. At the first plunge the wave surged quite 3ft. over the bow ends of the logs, and at the front of the centre portion water came up about ankle deep. Of course there was a good deal of spray, and those folks on the seats did not by any means escape this secondary effect. We had two such experiences on our way down, both of which afforded much amusement. I understand that the paternal police superintendent forbade the raft trip when first organised, and that the local committee only carried their wish by agreeing to insure every passenger for the modest sum of 50,000 marks—*i.e.*, £2,500—so that they should at least be worth drowning. We disembarked at Ludwigsbrucke to view the distributing system of the company. The following is a brief description.

The Isar Works.

It was towards the end of the eighties that Mr. Heilmann, of Munich, conceived the idea of utilising for industrial purposes the water power of the Isar, a tributary of the Danube. The most suitable spot for the undertaking was found to be the narrow valley near the old lime furnaces in aptly-named Höllriegelsgereuth. It was also found to be necessary to secure the rights over the whole of the stream from Baierbruun to Grosshesselohe (see map),

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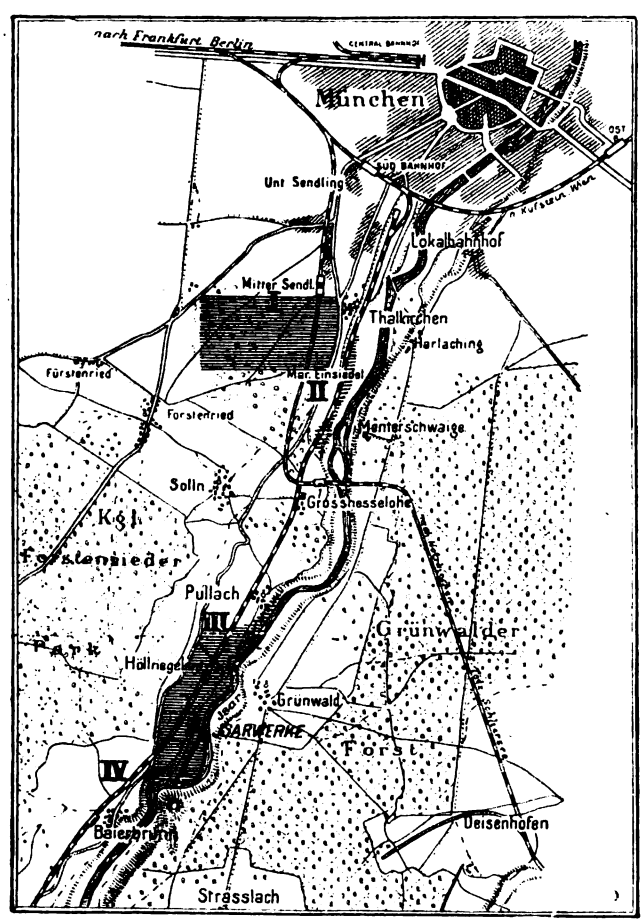
which represents, with an average depth of water, 6,000 h.p., and in winter, with the water low, 4,000 h.p. To utilise the water power it was essential to construct at Höllriegelsgereuth a massive weir in order to collect the water and conduct it to a channel on the left bank of the Isar. The concession for the works was given in 1891, and they were completed within four years.

On the left bank of the river the dam, 110 yards long, is connected with the sluices—viz., two concrete sluices each 10ft. wide inside, a float-passage 23ft. wide, and six canal sluices of a total inside width of 85ft. The canal, which has a sill width of 85ft. (3ft. wider than the Suez Canal, and 12ft. wider than the Baltic Canal), a smooth-water width of 109ft., and a depth of water of 6ft., is capable of passing 1,940 cubic feet of water per second. At high water the depth can be increased to 8·5ft., and the quantity to 2,300 cubic feet per second. At a distance of 880 yards below the weir is placed the first plant, with a capacity of 2,000 h.p. This plant consists of the turbine-house, a tailrace, and a float-passage. The whole of the



Plan showing the Isar Works and surrounding country.
I. Mittersendling Station. III. Hollriegelsgereuth Station.
II. Maria Einsiedl Station. IV. Baierbrunn Station.

foundations and waterworks are built with Portland cement on piles. The canal and weir works for utilising the total 6,000 h.p. from the Isar have now been completed, so that only the necessary buildings, etc., for the second and third plants are required. The whole of the concrete work was carried out by Messrs. Widmann and Telorac, of Kempten.

The present turbine-house is to be fitted with four Jonval 500-h.p. turbines, driving the same number of alternators. The arrangements made for keeping the ice from the weir, carrying it away from the first plant, and for preventing the turbines from freezing, have already proved satisfactory, despite the exceptionally severe winter. At present two turbines are in place and working, but the others can be put in position in a very short time and without interrupting operations. The turbines in the machinery building are geared by mortice bevel gearing to three-phase rotary-current dynamos made by Brown and Boveri. There is also on the same shaft an ordinary continuous-current dynamo for excitation, which delivers current by means of sliding contacts to the windings of the star-shaped magnets which are fixed on the flywheel. The armature core and coils are enclosed in a rigid iron frame, which is capable of rotation round the same axis as the magnets to bring any desired coils to a convenient position for examination. Contact is made automatically when the frame is barred round into its original position. This is done by means of knife contacts on the frame, which engage into jaws attached to the concrete in the gap of the foundation.

The three-phase currents, generated at 5,000 volts by the dynamos, are conveyed to the switchboard, and there can be connected to the mains going to the distributing stations. The switchboard is designed with a view to the safety of the operator, the 5,000-volt switches being placed out of reach and operated by means of long wooden handles. Mr. Oskar von Miller designed the electric plant and superintended its erection.

The energy obtained is used for power, lighting, and heating purposes, and is conveyed to the individual consumers by bare copper conductors, 0·300in. diameter, carried on high poles. In the transmission, to a distance of 5⅝ English miles, of a current produced by 1,000 h.p. the loss only amounts to 9 per cent. The current is transformed down from 5,000 volts to 100 volts before it is supplied to consumers.

The water and electricity works at Höllriegelsgereuth came last autumn into the possession of a limited company, with the title "Isarwerke," which supplies electric energy for power and lighting purposes at very cheap rates. In Thalkirchen alone 2,100 16-c.p. lamps are run from the Isar works, and 400 more are being fitted. As to the supply of power, electric motors of 140 aggregate horse-power are so far in use. Among the firms in Thalkirchen availing themselves of the new facilities for obtaining motive force the following trades are represented: joiners, venetian-blind makers, engineers, saw-mills, corrugated-iron makers and galvanisers, laundries, and brewers. Various other industrial establishments which are either projected or in course of construction at Mittersendling will also derive their power from the Isar works.

In the offices of the manager, Herr Drentwett, a collection of electrical novelties is shown, as well as the practical application of electricity to household requirements.

THE LENOX AVENUE CONDUIT RAILWAY.

The conduit of this railway, which was designed and manufactured by the General Electric Company, has now been put into operation, and is running very successfully. The engravings presented herewith will give an excellent idea of the construction employed.

In installing the line, the street railway company proceeded upon the most conservative lines, and determined to reduce the consequences of failure to the minimum of damage which would inevitably arise from any stoppage in the service. The plan, therefore, contemplated the construction of the line as if for a cable road, in order that, should the electrical system prove unsuccessful, the electrical portion could be taken out, and the cables and pulleys of a regular cable system introduced into the conduit, without loss of time, and at comparatively small expense.

The Lenox-avenue line is a double-track road, starting at the car-house at 146th-street, and running directly south to 116th-street, into which it runs, and proceeds as far west as Manhattan-avenue. It turns here, and runs as far south as 108th-street, along which it is carried to the junction of that street and Columbus-avenue. The district which this line will serve is at present somewhat sparsely settled, but the facilities of transit which it will afford will probably result in the rapid development of that region.

The power house is a temporary frame structure, with a sheathing of corrugated sheet iron, located on 146th-street, a few yards west of Lenox-avenue. Steam is supplied from two Babcock and Wilcox water-tube boilers, arranged in one battery. Each has a rated capacity of 250 h.p., furnishing steam at 120lb. The engines, two in number, are horizontal, cross-compound Allis-Corliss machines, which, during the experimenting trips, will run non-condensing. All the steam-piping is placed beneath the

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floor of the engine-room. To each of the engines is coupled a General Electric 400-kilowatt generator, of standard construction, but wound for 350 volts, instead of 500 volts, as is the usual practice in railway work. This machine is placed between the high and low pressure sides of the engines.

From the generators the cables run beneath the switchboard to a subway under the sidewalk on 146th-street, extending as far as Lenox-avenue, where they are introduced into the 5in. iron pipes running parallel with the conduit. For the present the line will be operated directly from the new power-house, but the feed wires will probably be placed in the pipes and will be tapped into the conductor at the necessary points.

The construction of the underground contact system is simplicity itself. The plough suspended from the crossbar of the car truck passes through the slot in the centre of the track and presses against the flat surfaces of two iron conductors running the entire length of the conduit. These conductors are placed each 3in. on each side away from the centre of the slot to avoid deleterious

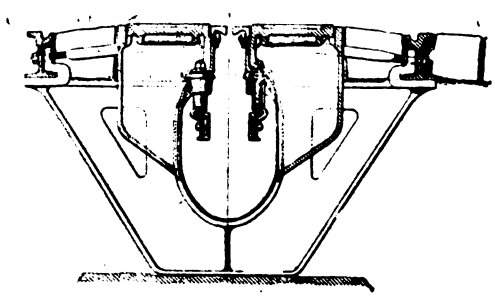

FIG. 1.—Section of Conduit—Insulator Suspension.

effects of any drip which would otherwise reach them, and are of channel iron, weighing about 21lb. to the yard. The rails are 4in. deep and are manufactured in 30ft. lengths. They are suspended for most of the way from the yoke by insulators devised for this especial purpose, and are at a depth of 13in. below the conduit slot. Each insulator is held in a cast-iron bracket, into which is tapped a bolt, Figs. 1 and 3. The shank of this bolt is surrounded by an insulating composition to a thickness of about $\frac{1}{4}$in. Surrounding this is $1\frac{1}{16}$in. of mica, and around this $\frac{3}{8}$in. of porcelain or of an insulating compound, both being now tried. The head of the bolt is surrounded by an insulating compound in the socket in which it is embedded. The socket is fastened to the slot rail by two bolts.

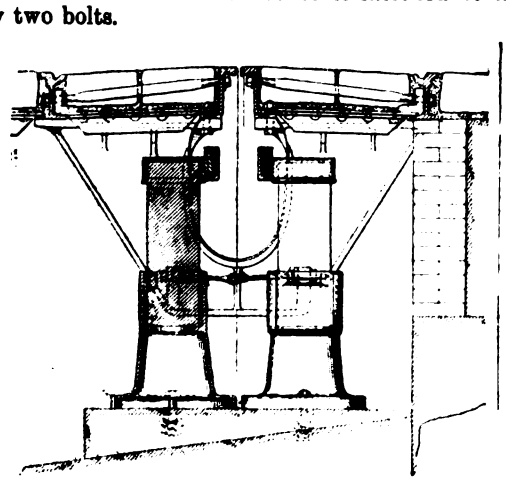

FIG 2.—Section of Conduit—Pedestal Support.

The insulators are located every 15ft., one at each manhole, which are 30ft. apart on straight track, and one at each hand-hole, which are located midway between the manholes. The insulators at the hand-holes are the same as those at the manholes, but the method of attachment is slightly different.

The conductors are bonded to each other by stranded copper wire securely riveted into the web of the metal.

A modification of this system of suspension of the conductors is introduced for a length of about 100 yards of single track on 116th-street, between Lenox and Seventh avenues. This is known as the pedestal method of support. At the manholes, instead of insulators suspended from the ceiling of the conduit, the conductors are supported by a soapstone pillar. The channel bar conductors in this case are 5in. deep, and are set 12in. below the slot. The soapstone pillars are provided with iron caps furnished with brackets, to which the conductors are bolted, and continuous connection is secured by means of a bond of flat copper strips riveted to the webs. The soapstone blocks are set in iron bases erected in the manholes.

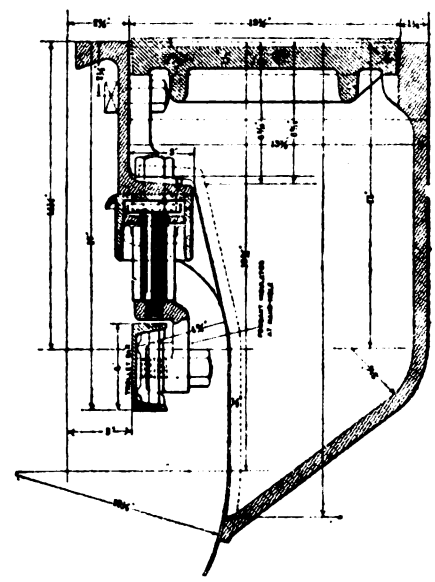

FIG. 3.—Enlarged View of Insulator Suspension at Handhole.

Every twelfth manhole is connected with the power-house by telephone. Quick-break switches are located at intervals in these manholes, in order that any section of the line may be cut out in case of trouble or accident. At the track switches each conductor is provided with a

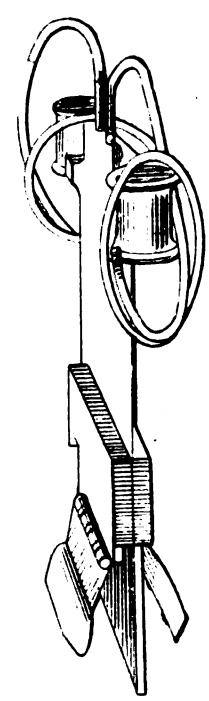

FIG. 4.—Plough.

flaring nose to facilitate the entrance of the plough into the conductors. The manholes in which the insulators are placed are 4ft. 4in. in depth, 4ft. in length, and 14ft. $5\frac{1}{2}$in. in width—that is, the entire distance of the two tracks. They are constructed of brick with 8in. walls that rest on concrete foundations. The floors are laid with 6in. of concrete and are provided with drains for carrying off water. With this provision for drainage no trouble from water in the conduit will, it is believed, be experienced. The conduit was built along the grade of the street, but with sufficient pitch to permit any water flowing into the conduit to

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find its way into the manholes, located every 30ft., and from thence into the sewers. Each conductor forms one side of the working circuit, and the current is thus insulated through the circuit.

The plough or travelling contact arrangement is also essentially novel. The contact-pieces are of cast iron, and are supported on spring leaves, which cause them to press outwardly against the two conductors, a pressure with about 6lb. The conductors, which are of sheet copper taped, are brought up to the car, and are protected on each side as they pass through the slot by sheet steel. Manganese steel presents evident advantages to this work and will probably be employed. A heavy sheet of fibre is located between the contact shoes to prevent arcing.

The motors employed are the standard General Electric 800 machines controlled by K 2 controllers.

WHELESS ELECTROMAGNETIC RAILWAY SYSTEM.

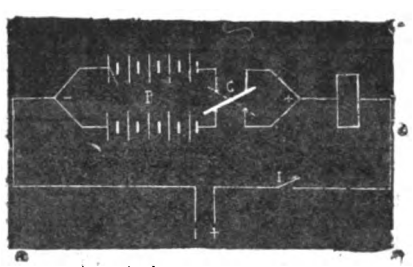
The Westinghouse Electric and Manufacturing Company, U.S.A., have acquired the patents of the Wheless system, which is in operation on the Belt Railway, of Washington, D.C. The apparatus consists of contact-pins placed between the rails and connected to junction-boxes located about 1½ft. outside of the rails on one side. The pins are arranged in groups of three each, and are of chilled cast iron 5in. in diameter. They are set in granite or terracotta blocks, which are bolted to the ties and are connected by a conduit with the junction-boxes. Communication is made to the car by means of collector bars located under the latter, which are of T iron, 2in. by 2in. suspended on springs. These bars are long enough to reach from one set of pins to the next, and at the same time entirely clear the pavement. Two contact-pins of each group are so connected through a magnet in the junction-box that when a current has passed from one pin to the other the magnet is excited, making connection between the feed wire and return, and one of these pins and the third pin. The exciting current is provided by three cells of a storage battery carried on the car and supplying six volts and 15 amperes. When the car has passed, the contact is broken and the knobs are no longer alive. To prevent arcing inside the junction-box the contact surfaces are of carbon, two in number and each about 2in. by 2in. On the railway mentioned, in Washington, a line about three fourths of a mile long on North Capitol-street from New York-avenue to P-street has been in operation for about six months with very satisfactory results. On that line the space between the contact-knobs and the rails where surface leakage might be apt to occur is not even paved. The soil is clay, and in wet weather the mud is on a level with the rails. The surface leakage was about half an ampere, with one car running, with the ground covered with water, and with 500 volts. The Westinghouse Electric and Manufacturing Company is now constructing an experimental line on this system, about one mile in length, at its works in Pittsburgh.

THE GABARRO DRY CELL.*

The following is an account of some experiments which have been made with the dry cell invented by Señor Gabarró-Julien, which has recently attracted much attention in Spain. With elements of comparatively small dimensions, a motor of $\frac{1}{16}$ h.p. was supplied, which drove a Singer sewing-machine with considerable rapidity and regularity. The same battery applied to two small 10-c.p. incandescent lamps, arranged in series, at a pressure of 10 volts, produced a good steady light, quite equal, it is stated, to that of the lamps of same type of the electric lighting companies in Madrid.

The cell consists of a small wooden case, 6¾in. high, 9½in. long, and 6½in. wide. In the upper part there are two small terminals, each in communication with the corresponding electrodes, the positive being a bar of carbon, the negative a cylinder of amalgamated zinc. The chemical substance which acts upon the zinc, working at the same time as a depolariser, is a special paste, the composition of which is the secret of the inventor. The cell, according to documents attested by electricians such as Picou, Fschieret, Volt, and Tommasi, yields a pressure of 12 volts at the commencement of the discharge, which drops after a little to nine volts, which is steadily preserved to the end. The current is of about three amperes, and the interior resistance is about three ohms when the cell is in closed circuit.

The cell has the advantage of cheapness, as, its approximate duration being, it is said, 200 hours, each element costs only about 4s. It has, however, its disadvantages. It polarises itself in five minutes after being in circuit; but, on the other hand, it recuperates at once when switched off without losing any of its qualities, and when the circuit is open there is no internal waste. This drawback—a rather important one where, say, electric lighting is concerned—can, Sr. Villegas observes, be easily remedied by a suitable arrangement somewhat similar to that shown in the annexed cut, where P is the battery distributed in two sets of cells, C the automatic commutator, R the automatic regulator, and I the interrupter, or switch. The automatic regulator is introduced in the circuit with the view of correcting the variations of voltage. Sr. Gabarró constructs the plates of specific dimensions according to the purpose for which the battery is to be used.



Sr. Gabarró-Julien, we are informed, being confident that there will be an extensive demand for his cell, which he has patented in several countries, is about to manufacture it on a large scale.

[It is interesting to note that the Spanish nation is at last waking up and launching its electrical inventions into the world. As is to be expected, their first inventions to be exploited are primary batteries, and we can assure Sr. Gabarró Julien that a perusal of our English papers of 10 years back would have saved him much time in preparing the description of the qualities of his invention. The only item we miss is that of the extremely valuable by-products which these new batteries usually yield. The large demand, however, for these batteries for motive power and light will not come from foreign countries.—Ed. *E. E.*]

EXPERIMENTS ON THE RELATION OF HYSTERESIS TO TEMPERATURE.*

BY FRANK A. LAWS AND HENRY E. WARREN.

(Concluded from page 691.)

The furnace used for heating the specimen was built of firebrick; the external diameter was about 36in., height 18in. Inside the firebrick was a layer of asbestos wool 2½in. thick, kept in place by asbestos board, which was protected by thin sheet iron. The box containing the specimen was made of asbestos board about 1½in. in thickness, and lined with retort cement. During the tests it was tightly closed. The furnace was heated by three blast jets made of gas-pipe; the external tubes were ¾in. inside diameter, the inner tube ⅜in. The supplies of gas and air were regulated by slide valves. The jets were directed into the furnace tangentially and with a slight upward inclination, the effect being to establish a good circulation and keep the interior of the furnace at a uniform temperature.

The specimen upon which the following tests were made

* Señor Gumersindo Villegas, in *El Telegrafista Español* of July 8.

* Contributions from the Physical Laboratory of the Massachusetts Institute of Technology to the *Proceedings* of the American Academy.

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was composed of so-called French steel, which showed on analysis the following impurities :

	Per cent.
Manganese	0·535
Phosphorus	0·013
Silicon	0·085
Sulphur	0·018
Carbon	0·970

The mass of iron employed was 628 grammes. From this material, which was $\frac{4}{1000}$in. thick, rings of 3in. outside and 2in. inside diameter were stamped, and the specimen formed by piling them. Each was insulated from its neighbours by a layer of pipeclay, applied as a sort of paint, the clay having been moistened with alcohol. Every tenth layer was insulated with mica. The pile so formed was wrapped with asbestos cloth, and the magnetising coil of 36 turns of No. 14 copper wire wound on. The wire was insulated by winding it with asbestos twine. Interwound with the magnetising coil was the B coil of 24 turns. These two windings formed on the outside of the specimen a single layer. The temperatures were determined by a Le Chatelier pyrometer, calibrated by known melting points. The hot junction was placed inside the asbestos wrapping resting against the iron, the leads were brought out through the usual double-cored fireclay tube; this was surrounded by a piece of gas-pipe thoroughly wrapped in asbestos cloth, because in using this pyrometer in a case like the present, where the leads pass from the

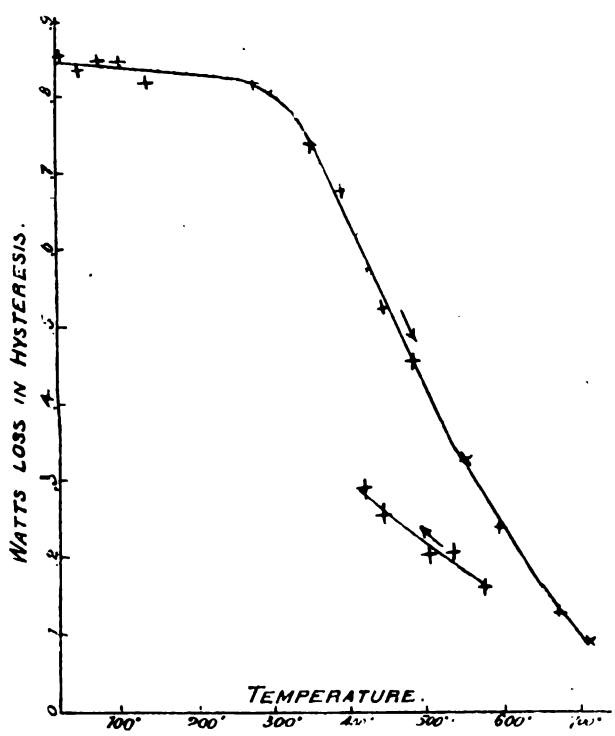

Fig. 3.

hot junction through a space at a higher temperature at a short distance from the junction, it is necessary to guard against conduction along the leads, and consequent errors in the temperature.

The manner of making the tests and the subsequent calculation was as follows: Owing to the construction of the furnace, the specimen being well shielded from the heat of the flames by the internal chamber, the air insulation, and its own asbestos covering, the temperature of the iron rises gradually; consequently, the specimen will be at very nearly a uniform temperature. When a reading is desired, the alternating current is turned on and the B deflection adjusted to its maximum value by K^1, and to its correct numerical value by varying the magnetising current. Watt-balance resistance r_1 is now adjusted, and the pyrometer reading corrected for zero, and dynamometer reading and time observed; after a few minutes the observations are repeated, the temperature having risen in the meantime. This process is kept up until the iron loses its magnetism Occasionally, a direct current was sent through the apparatus and the watt-balance, dynamometer, and pyrometer readings taken; these allow the value of r_1^1 in the hysteresis formula to be determined by making a plot, the co-ordinates being watt-balance and pyrometer readings—from the plot the value of r_1^1, corresponding to any pyrometer reading may be read off. The electrodynamometers were calibrated by sending a direct current through them, and measuring the P.D. at the terminals of a known resistance by projection against the E.M.F. of a Clark cell; the values of deflections and currents squared were plotted, giving straight lines. I^2 was determined by reference to these plots. The zero errors of the dynamometers employed were very variable, and were determined after each reading.

The results of the measurements will now be given. They are plotted as referred to at the beginnings of the several tables.

Table I.—First heating : Ascending curve. See Fig. 3.
B = 1,970. n = 125. W_H = Hysteresis loss in specimen.

W_H.	Temp deg.	W_H.	Temp deg.
·852	23	·678	387
·834	45	·526	440
·845	67	·456	481
·845	98	·331	546
·817	132	·241	595
·809	181	·130	672
818	272	·088	709
·742	347		

The specimen lost its magnetic properties so rapidly that further measurements could not be taken on the ascending curve.

Table I.—Descending.

W_H	Temp. deg.
·0	787
·161	576
·206	503
·255	445
·290	417

Power shut off.

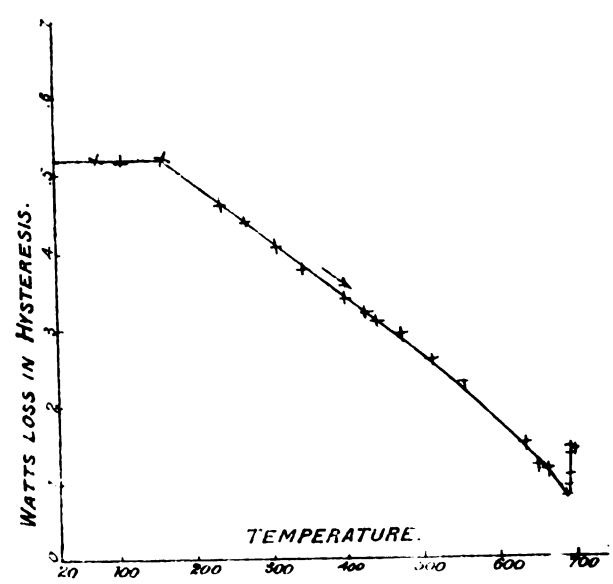

Fig. 4.

Table II.—Second heating : Ascending. See Fig. 4.
B = 1,974. n 125.

W_H.	Temp. deg.	W_H.	Temp. deg.
·516	20	·149	632
·520	75	·121	653
·519	108	·115	662
·522	160	·093	679
·440	269	·083	688
·407	310	·094	692
·378	345	·104	693
·340	397	·130	693
·321	423	·130	693
·311	438	·142	693
·293	470	·144	693
·258	511	·142	692
·228	555	·140	694
·167	593		

Inspection of the plots shows (Figs. 3 and 4) that for this sample of steel a moderate elevation of temperature, up to about 270deg., has but a small influence on the hysteresis loss; that at this point a change takes place, and the diminution of hysteresis, with rise of temperature, is much more rapid, the decrease being such that at 675deg. the loss is but 13 per cent. of its value at ordinary temperatures. After heating above the inflection point, the specimen

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shows on cooling a marked decrease of the hysteresis loss from its value at the same temperature on the ascending curve. If the specimen be heated again, a change of direction of the curve takes place, but at a lower temperature. The second plot, Fig. 4, shows an increase of the hysteresis loss after the point of inflection has been reached. As only two heatings were made we were unable to verify these observations, the results of which became apparent only when they were reduced. In addition to the experiment at high temperatures the following observations were made: A specimen was made up and the loss measured at the ordinary temperatures. A mean of three measurements gave ·289 watt as W_H. The specimen was then covered with a mixture of solid carbonic acid and ether. A mean of three measurements showed W_H as ·288 watt, showing that there is practically no change of hysteresis for a diminution of temperature to about 80deg.

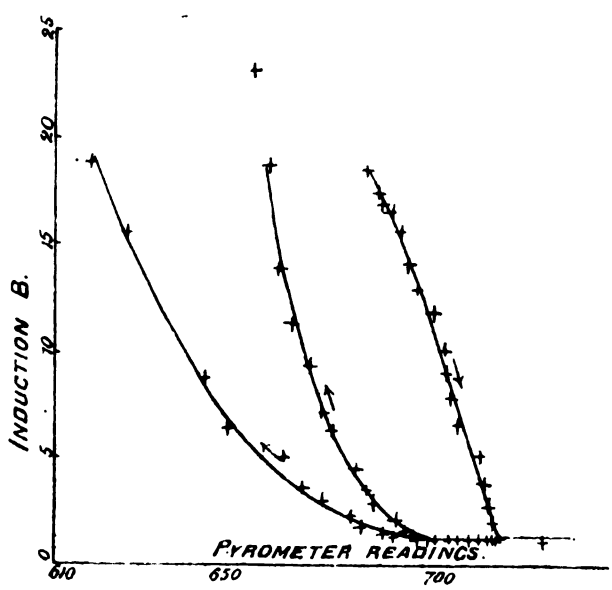

FIG. 5.

Between the ascending and descending observations of the second heating, readings were taken for the purpose of finding whether the temperature at which the iron becomes markedly magnetic on cooling is the same as that at which the sudden diminution of the magnetic properties occurs on heating. Simultaneous readings of the B galvanometer and pyrometer were taken; the current remaining constant, no adjustment for maximum was made. The readings, together with some from the descending curve of the first heating, are given below, and, after being corrected for zero, are plotted in Fig. 5.

TABLE III.

First heating.		Second heating.	
B reading.	Pyr.	B reading.	Pyr.
38·8	7·17	28·1	6·99
38·8	7·10	29 9	7·01
38·8	7·05	31·0	7 02
38·8	7·00	32·1	7 03
38 7	6·95	33·4	7 05
38·55	6·90	34·8	7·10
38·15	6 83	36·1	7·11
37·70	6·80	37·2	7·12
37·00	6·73	37·9	7·13
36·3	6·69	38·3	7·14
33·65	6·51	38·6	7·15
31·2	6·45	38·7	7·15
		38·6	7·19
		38 8	7·14
		38·75	7·10
		38 75	7 03
		38·7	7·01
		38 65	6 98
		38 55	6·95
		38·25	6·93
		37·85	6·90
		37·1	6 85
		36·5	6·84
		34·1	6·76
		32·7	6 73
		30·7	6 70

Fig. 5 shows that the two points do not coincide, that on the descending being about 12deg. lower than that on the ascending curve. The difference of form of the curves is noticeable, showing that the regaining of magnetic properties on cooling is more gradual than their loss on heating; the sudden exaltation of magnetic properties occurs at the same temperature in the first and second coolings.

At the time of this writing the research has not been fully completed. We are, however, now engaged on further experiments, and hope to present additional data in the near future.

ELECTRIC LIGHTING PROVISIONAL ORDERS.

A copy of memorandum stating the nature of the proposals contained in the provisional orders included in the Electric Lighting Provisional Orders (No. 4) Bill has been published.

Notting Hill Electric Lighting Order, 1895.—The undertakers under this order are the Notting Hill Electric Lighting Company, Limited. The area of supply is a portion of the parish of St. Mary Abbotts, Kensington. The order is to be read in conjunction with the Notting Hill Electric Lighting Order, 1889, and extends the area of supply authorised by that order.

St. Olave Electric Lighting Order, 1895.—The undertakers are the County of London and Brush Provincial Electric Lighting Company, Limited. The area of supply is the district of the St. Olave District Board of Works. The order contains provisions (1) that the undertakers shall lay down mains in certain specified streets within a period of two years, and it provides for the supply of electrical energy within the remainder of the area on certain specified conditions; (2) for the deposit of a certain sum as security for the execution of works; (3) for the audit of the accounts of the undertaking; (4) for the approval by the Board of Trade of the system upon which energy is to be supplied and the issue by them of regulations for securing the safety of the public and for ensuring a proper and sufficient supply of energy; (5) for the execution of the necessary works and the breaking up of streets, etc., and the alteration of pipes, etc., under streets; (6) for regulating the manner in which energy is to be charged for and fixing the maximum price to be charged; (7) for the appointment, remuneration, and duties of electric inspectors, and the testing of electric lines and other works; (8) for the supply, use, certifying, inspection, etc., of meters; (9) for the revocation of the order under certain circumstances; (10) for securing that the undertakers shall not purchase or acquire the undertaking of, or associate themselves with, any other company or person supplying energy under any license, provisional order, or special Act within the administrative county of London unless the undertakers are authorised by Parliament to do so; (11) for prohibiting the supply of energy by the undertakers beyond the area of supply otherwise than under the authority of Parliament or under a license granted by the Board of Trade; (12) for prohibiting the use of overhead wires without the consent of the Board of Trade and the London County Council; (13) for enabling the London County Council or the local authority, as the case may be, to require the undertakers to place their mains, etc., in subways where such subways exist.

Strand District Electric Lighting Order, 1895.—The undertakers are the Charing Cross and Strand Electricity Supply Corporation, Limited. The area of supply is the district of the Strand District Board of Works. The order contains provisions similar to those referred to in the case of the St. Olave Electric Lighting Order, 1895, above mentioned.

LEGAL INTELLIGENCE.

DAMAGE TO A CABLE.

On Monday in the Court of Appeal, before the Master of the Rolls, Lord Justice Kay, and Lord Justice A. L. Smith, the case of the "Caloric" was heard.

This was an appeal from a judgment by Mr. Justice Day, sitting in the Admiralty Division. The action was brought by the Direct Spanish Telegraph Company against the owners of the steamship "Caloric." The plaintiffs were the owners of a submarine telegraph cable laid down between the coast of Cornwall and the port of Bilbao, and they claimed damages for injury to their cable caused by negligence or want of care and skill on the part of the defendants or their servants in the navigation of their ship the "Caloric." On November 14, 1894, the ship, which was then bound in ballast from Bordeaux to Bilbao, arrived at Bilbao Bay and anchored in 14 fathoms of water. Shortly afterwards a pilot came on board and ordered the master to move from his position. The master was accordingly preparing to heave his anchor when the ship commenced dragging, and it was discovered that her anchor had become entangled with two

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cables, one of them being the plaintiff's cable, and the other, which was smaller, being a disused cable. The master having brought the anchor to the surface adopted the best measures he could think of for freeing it from the cables, and after the crew had been working with this object for some time, the sea being rough and the wind very heavy, the larger cable began to strand, and at last snapped. Finding that the ship still dragged, and believing that there was imminent danger of her going ashore, the master ordered the smaller cable to be cut. This having been done by chopping with an axe, the anchor was got in, and the ship was able to speed ahead. At the trial the plaintiffs endeavoured to prove that it was their cable which had been cut, but the learned judge who tried the case with the assistance of the Elder Brethren of the Trinity House, having had inspection of the cable itself, came to the conclusion that it had not been chopped with an axe, but that the facts were as above stated. Being further of opinion that there had not been any negligence on the part of the master or crew of the "Caloric," the learned judge gave judgment for the defendants. The plaintiffs appealed to this Court. They admitted that they could not any longer contend that their cable had been cut, but they argued that it was the duty of the master under the circumstances to slip his anchor.

Mr. Cohen, Q.C., and Mr. Butler Aspinall appeared for the plaintiffs; Sir Walter Phillimore and Mr. Holman for the defendants.

The **Court**, without calling upon counsel for the defendants, dismissed the appeal.

The **Master of the Rolls** said there was no doubt that the captain of the "Caloric" had been placed in a difficult position. His anchor had become entangled with the plaintiffs' cable, and while he was taking reasonable precautions to get his anchor free, in circumstances of some danger, the plaintiffs' cable had broken. It was all very well for the plaintiffs now to say that he ought immediately to have sacrificed his masters' property in order to save theirs. But the question was whether he had done anything wrong or negligent, whether he had failed in any duty which was cast upon him by the circumstances in which he found himself. The learned judge in the Court below, who had the assistance of the Trinity Masters, held that the captain had not been guilty of any negligence, and those who were now assisting the Court were of the same opinion. There was no ground for alleging negligence of any kind against the captain. The action therefore could not be maintained, and the appeal must be dismissed.

The **Lords Justices** concurred.—*The Times.*

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ille-sur-Tet.—Le Mairie d'Ille-sur-Tet, Pyrénées-Orientales, invites tenders by August 11 for the concession of the electric lighting of the town.

Brussels.—Le Gouvernement Provincial invites tenders by August 2 for a concession for the construction and working of a tramway from the Bourse in Brussels to Koekelberg and Jette-Saint Pierre.

Dortmund.—The Stadtgemeinde invite tenders by August 14 for the construction of a large electric central station. Conditions and plans may be obtained for one mark from Das Magistratsamt, Dortmund, Germany.

Belfast.—The Corporation Electric Light Committee invite tenders by July 24 for the construction of street culverts, insulated cable, copper strip, insulators, etc., for one year. Particulars are obtainable from the engineer at the central station, Chapel-lane

Brighton.—The Corporation invite tenders by August 10 for the supply and erection at the electricity works, North-road, of evaporative brass-tube surface condensers, electrically-driven air-pumps, exhaust and condenser piping. Specifications can be obtained from the town clerk. Further particulars appear in our advertisement columns.

Whitehaven. — The Town Council invite tenders for (among other stores) electric fittings and incandescent lamps as may from time to time be ordered during the year ending July 31, 1896. Applications for forms of tender must be made to the borough engineer and surveyor, Town Hall, Whitehaven, and sealed tenders, addressed to Mr. Thomas Brown, town clerk, Town Hall, Whitehaven, must be delivered by 10 a.m. on 26th inst.

Cowes.—Tenders are invited by the Urban District Council for laying down an electrical plant of sufficient capacity to keep burning at the same time 2,200 8-c.p. lamps, and also for public lighting and the laying of mains to accommodate 3,000 lights at the same time. The length of the road to be lighted is about a mile. Particulars can be obtained from Mr. Nelson F. Dennis, A.M.I.C.E., engineer to the Council, Cowes. Tenders are to be delivered by August 27.

Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

Bristol.—Tenders are invited for the supply of (a) pea nut coal, washed; (b) pea nut coal, unwashed, to the electrical lighting station, Temple-back, Bristol, for 12 months from August 1, for the Electrical Committee. A copy of specification and forms of tender can be obtained from Mr. Frank Wm. Prosser, secretary, Electricity Department, Temple-back, Bristol. Tenders must be delivered by noon on 26th inst., addressed the secretary, Electricity Department, Temple-back, Bristol, and endorsed "Tender for Coal."

London, W.—The Hammersmith Vestry invite tenders for complete schemes for public and private lighting, and for the supply of motor power in that portion of the parish of Hammersmith described in the provisional order as the compulsory area. Memoranda of instructions, with a map of the district, may be obtained from Mr. H. Mair, surveyor to the Vestry, on or after July 10, 1895, between the hours of nine and five, Saturdays nine and one, on payment of a deposit of £10, which will be returned to persons sending in a *bonâ fide* tender. Tenders are to be delivered at the meeting of the Vestry, at the Vestry Hall, at 6.30 p.m. on September 4.

Datchet (Berks.).—Tenders are invited for lighting the village of Datchet, for the Barker's Bridge House Trust, during October to March, with oil, gas, or electricity. The present number of lamps is 33. Any further number hereafter to be erected in the parish to be included at the rate quoted. Tenders may be for lighting partly by one method and partly by another. The lamps must be lighted at sunset and kept alight until 1.30 a.m. The contractor must supply all requirements and fittings for the lamps (the present posts and lamps being available as far as they will serve) for the lighting as above specified, and must keep the lamps clean and in good repair to the satisfaction of the trustees. Tenders must be sent to the trustees of Barker's Bridge House Trust, care of Mr. H. L. Prior, The Priory, Datchet, by 6 p.m. on 20th inst.

Derby.—The Electric Lighting Committee of the Corporation invite tenders for the builder's work in the boiler seatings for three new boilers and in new coal-store, etc., and accessories, at the central station. Plans may be seen on application to Messrs. Bramwell and Harris, engineers, 5, Great George-street, Westminster, S.W., or to the town clerk, Town Hall, Derby, from either of whom may be obtained, on deposit of £2. 2s., to be returned on receipt of a bona fide tender, a printed copy of the specification, form of tender, and bill of quantities. Tenders, on the prescribed form, must be delivered, with the specification attached and unaltered, enclosed in a sealed envelope, endorsed "Electric Lighting—Tender for Buildings," and addressed to Mr. H. F. Gadsby, town clerk, at the Town Hall, Derby, by 12 noon on 22nd inst.

Valletta (Malta).—Sealed tenders will be received at the office of the Receiver-General and Director of Contracts, Valetta, or at that of the Crown Agents for the Colonies, Downing-street, London, until 11 a.m. on August 1, for the supply of materials in connection with the installation of the electric light in the civil and war department buildings in Malta. The materials are comprised under four headings—viz., (1) cables and wires, (2) tools, etc., (3) fittings, fixtures, etc., (4) sundries. Printed forms of tender and of the specifications and conditions may be obtained on application at the above office, Valletta, or at the office of the Crown Agents for the Colonies, Downing-street, London. Each tender must contain the name of the surety whom the tenderer intends to propose for securing the performance of the contract and the payment of the penalties therein established. The surety to be a person residing in the island. No notice shall be taken of any tender not accompanied by a deposit, to be made in the office of the Receiver-General and the Director of Contracts, Valletta, or in that of the Crown Agents in London, of a sum of £5 sterling, to be forfeited to the Government should the party tendering, or his surety, in the event of the tender being accepted, fail to appear for signing the contract within three days from the day of the notice given to them to that effect. If the tenderer is not resident in Malta, his tender must contain the name of an agent residing in the island, to whom, in the same tender, power must be given to represent the tenderer in the contract. Any tenders which may be delivered at the Crown Agents' office must be in sealed packets addressed to the "Director of Contracts, Malta—Tender for Materials for Electric Lighting," under cover addressed to the Crown Agents for the Colonies.

RESULTS OF TENDERS.

Birkenhead.—The tender of Messrs. W. A. Shaw and Co., Stockport, £800, has been accepted by the Town Council for providing a system of fire alarms throughout the borough. After this tender had been recommended for acceptance an error of omission of £85 was discovered. It being still the lowest tender it was accepted as amended.—The Town Council also received the following tenders for the erection of the central electrical generating station in Bentinck-street: Messrs. J. Shaw, Birkenhead £4,900 (accepted); Messrs. Holme and Green, Liverpool, £4,440. After the latter tender had been recommended for acceptance an error of omission of £378 was discovered. The Town Council thereupon decided to take the next lowest tender.

London, N.E.—The following tenders have been received by the Hackney Vestry for the supply and delivery of cast-iron lamp-posts: Staveley Coal and Iron Company, Chesterfield, £10. 10s. per ton; Guthrie and Son, Leadenhall-street, £9; Hulett and Co., Limited, High Holborn, £9; Bagshaw and Son, Limited, Batley, £8. 10s.; J. C. and J. S. Ellis, Limited, Sheffield, £8. 10s.; McDowall, Steven, and Co., Limited, Upper Thames-street, £8. 10s.; J. Muir and Co., West Hartlepool, £8. 5s.; G. Smith and Co., Glasgow, £7. 14s. 7½d.; Newton, Chambers, and Co.,

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Limited, Sheffield, £7. 10s.; Tee Side Iron and Engine Works Company, Limited, £7. 5s.; Wells Bros., Nottingham, £7. 5s.; Constructional Ironworks Company, Limited, Bow, £7; Richards and Son, Leicester, £6. 15s.; Lucy and Co., Oxford, £6. 10s. and £7; Ceres Ironworks, Limited, Kingston-on-Thames, £6. 13s. 4d.; Jukes, Coulson, Stokes, and Co., Clement's-lane, E.C., £6. 11s. 9d.; E. and F. Wright, Mile End New Town, £6. 10s.; J. Robinson, Sheffield, £6. 7s. 6d.; F. Bradley, Kidderminster, £6 5s.; J. F. Clark and Sons, Moorgate-street, £6 4s 6d.; Alloa Iron Company, £6; Hampton and Co., Walbrook, £6 (informal); Parsons and Sons, Dudley, £6; Skelton and Co., Lime-street, E C., £6; Pontifex and Co., Coleman-street, E.C., £5. 18s. 9d.; Gibb and Co., 99-100, Fenchurch-street, E.C., £5. 10s. (accepted).

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,356.

Telegraph Construction and Maintenance Company.—The Board has declared an interim dividend of 12s. per share.

West India and Panama Telegraph Company.—The receipts for the two weeks ended July 15 were £351 less than for the corresponding period of 1894.

London, W.—Messrs. Drake and Gorham have been entrusted with the electric lighting of Sir Richard Quain's London house in Harley-street. There will be about 120 lights.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 14th inst. amounted to £1,186, as compared with £905 in the corresponding week of last year, being an increase of £281.

Marylebone.—Mr. Brooke Hickling, of the Marylebone Vestry, has carried a motion unanimously on the Vestry for appointing a special committee to consider and report as to the desirability of lighting the parish by electricity.

Poplar.—A letter from the Capital and Counties Electricity Supply Company stating that they proposed to apply for an order to light the district of the Poplar Board of Works has been referred to the Works Committee.

Weston-super-Mare.—Mr. Dubin, a member of the Urban District Council, has complained at a meeting of the body that Mr. Boyden, another member, had "fostered a scheme for electric lighting at a cost of £20,000, which would produce no direct profit for many years."

Anglo-American Telegraph Company.—After placing £6,000 to the credit of the renewal fund, the directors have declared interim dividends for the quarter ended June 30 of 11s. per cent. on the ordinary stock, and £1. 2s. per cent. on the preferred stock, payable on August 1.

Bexhill.—A meeting of the District Council was held on Monday, at which the Highways and Lighting Committee recommended that the water and gas company, with reference to lighting the streets with electricity, should be informed that the Council refused to pledge themselves in any manner. This was approved of.

Hove.—At the meeting of the Urban Council the Works and Improvements Committee reported that on the 25th ult. the electric light post in Church-road, opposite Fourth-avenue, was knocked down by an omnibus and the lamp and lamp column completely destroyed. The surveyor was instructed to reinstate the post.

Appointments Vacant.—Two assistant electricians are required for the St. Pancras Vestry's new electricity works at King's-road. Particulars will be found in our advertisement columns.—An assistant electrical engineer is required by the Tunbridge Wells Town Council at a salary of £100. Applications are to be sent to the town clerk by the 24th inst.

Harrow Electric Light and Power Company, Limited.—This Company has been registered, with a capital of £25,000, to take a transfer of all or any of the powers, duties, and liabilities by the Harrow Electric Lighting Order, 1894, granted to and imposed upon the undertakers therein mentioned, and to carry on business as suppliers of electricity at Harrow, Middlesex, or elsewhere.

Whitechapel.—The Vestry have received a notice from the Capital and Counties Electricity Supply Company, Limited, of their intention to apply on or before December 21 next, by memorial, to the Board of Trade for a provisional order to authorise them to supply electricity for public and private purposes within the area of the Board. It was resolved to consider the question at the next meeting.

Morecambe.—The District Council have held a meeting, at which the Finance Sub-Committee, respecting the purchasing of the electric light works, reported that a letter had been received from Mr. Jowett, secretary of the company, to the clerk, supplemental to the previous correspondence. It was resolved unanimously that the committee should see Mr. Parkinson, of Lancaster, electrician, with respect to valuing the undertaking, etc.

St. James's and Pall Mall Electric Light Company.—The directors have declared the following interim dividends for the half-year ended June 30, 1895: at the rate of 7 per cent. per annum on the preference shares; at the rate of 4 per cent. per annum on the ordinary shares. The sale of current for the quarter ending June 24, representing the supply at 6d. per unit, amounted to £8,598, as against £7,380 at the same rate for the corresponding period of 1894.

Stock Exchange Notices.—Applications have been made to the Stock Exchange Committee to allow the following securities to be quoted in the official list: City of London Electric Lighting Company, Limited—further issue of £200,000 5 per cent. debenture stock in lieu of the provisional certificates now quoted; and Tramways Electrical Traction Company, Limited—15,000 preference shares, Nos. 1. to 15,000, in lieu of the shares of the Tramways Company of France, Limited, now quoted.

Luton.—It was reported at the last meeting of the Town Council that the confirming Bill in reference to the Luton electric lighting received the Royal assent on June 28. A notice has been received from the Bedford Electric Company of their intention to apply to the Board of Trade for a provisional order for the supply of electrical energy within the area of the borough, but the company had since become aware that the Corporation had themselves obtained an order, and have therefore withdrawn the notice.

Heywood.—Alderman Healey, in moving the confirmation of the minutes of the Technical Instruction Committee at the last meeting of the Town Council, drew special attention to that requiring a certain number of students to ensure the formation of a class for any particular subject. There was a desire to promote every study, but the committee would have to discontinue magnetism and electricity, unless those subjects secured a reasonable number of students. Councillor Dearden seconded the proposition, which was carried.

Eastern Telegraph Company.—The directors of the Eastern Telegraph Company, Limited, announce that, subject to final audit, the accounts show, after placing about £100,000 to reserve, a balance available sufficient to pay the fixed dividend of 3s. per share, being at the rate of 6 per cent. per annum on the preference shares, less income tax, and a final payment of 2s. 6d. per share, with a bonus of 3s. per share, both free of tax, on the ordinary shares, making, with previous payments on account, a total distribution of 6½ per cent. on those shares for the year ending March 31.

City of London Electric Lighting Company.—The directors have declared an interim dividend on the preference shares of the Company at the rate of 6 per cent. per annum for the six months ended June 30 last, the dividend to be payable on and after the 25th inst. The gross revenue for the quarter ended with June amounted to £15,984, an increase of £5,669 compared with the corresponding quarter of last year. The equivalent of 8-c.p. lamps connected at the end of June was 159,250, an increase of 10,656 on the quarter, and of 60,110 compared with the corresponding quarter of last year.

Richmond (Surrey).—A letter from Mr. A. J. Lawson, engineer and manager of the Richmond (Surrey) Electric Light and Power Company, Limited, giving notice of their intention one month after the service thereof, to commence the execution of the works thereinafter described—viz., laying electric conductors along Ormond-road from Hill-street to site of new church, Petersham-road from Vineyard (Hill-rise) to Ivy Hall, in Lancaster-park, and also in Ellerker-gardens, Onslow-road, Montague-road, and Friars' Stile-road—was left in the hands of the Electric Lighting Committee at the last meeting of the Town Council.

St. Saviour's, S.E.—The Sanitary and Sewers Committee have reported to the Board of Works they had considered the question of a new underground public convenience at the junction of Southwark-street and Blackfriars-road. They also instructed the surveyor to prepare plans of the building, and an estimate of the cost had been submitted amounting to £1,725, exclusive of £125 allowed for diverting electric and other mains and removing the existing lamp-column. They recommended that the plans and estimates should be approved. Mr. Newton moved the adoption of the report, which, after a short discussion, was agreed to.

The Victoria-embankment.—We last week printed the report of the Highways Committee of the London County Council on the subject of the electric lighting of the embankment. At last Tuesday's meeting the matter was postponed for a week or two. In addition to Mr. Thornton's amendment, which we have already noted, Mr. Mr. E. White has given notice of the following amendment: "That the recommendation be referred back to the committee with instructions to ascertain and report what is the cost of the present lighting, what would be the cost of incandescent gas lighting, and what would be the cost of electricity supplied by a company."

Galloways, Limited.—This Company has been registered, with a capital of £115,000 in £100 shares, to acquire as a going concern the business and undertaking of a company with a similar title (incorporated April 3, 1889), in accordance with an agreement expressed to be made between the old company and Joseph W. Pollitt, the liquidator thereof, of the one part, and the new company of the other part; and generally to carry on business as engineers, boilermakers, iron and brass founders, rivet makers, copper and tin smiths, millwrights, machine and engineering toolmakers, general contractors, metal workers, steel converters, electricians, suppliers of electricity, consulting engineers, etc.

Fire at the General Electric Company's Works.—With reference to the fire which occurred at the Manchester works of the General Electric Company, Limited, on Friday last, we are informed that the business will in no way be interfered with, and that any orders received will continue to be executed promptly. The heavy stock in the warehouses in London, Manchester, and Glasgow, as well as the manufacturing capacities that the Company have in their various works and shops at Hammersmith, Clerkenwell, Thames-street, etc., will enable them to meet all emergencies for the next few months. In the meanwhile they

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are pushing forward with all possible speed the erection of plant, machinery, and tools in their new works—Peel Works, Adelphi, Salford.

City and South London Railway.—The returns for the week ending July 14 were £848, compared with £882 for the corresponding period of 1894, being a decrease of £34. The total receipts for the half-year 1895 are £1,763, as compared with £1,761 for the corresponding period of 1894, being an increase of £2 The accounts for the half-year ended June 30 show a balance, after providing for the debenture interest and the full dividend on the 5 per cent. preference shares, sufficient to allow the payment of a dividend on the consolidated ordinary stock at the rate of 1¼ per cent. per annum, carrying forward a balance of £965 to the new account. The dividend for the corresponding period last year was at the rate of 1 per cent. per annum, the balance carried forward being £1,336.

Copper.—"The increase in the visible supplies of copper, upon which we commented a fortnight ago," says the *Financial News*," has proved to be very short-lived, and the pressure of a growing trade demand is making itself felt, as we have all along asserted that it would do. Compared with June 30, there was on the 15th inst., according to Messrs. Merton and Co.'s circular, a decrease in stocks of nearly 1,000 tons, and, including shipments on the way from Chili and Australia, a total decrease from 58,182 tons to 56,911 tons. The price of Chili bars and G.M.B.'s has in the meantime risen from £42. 7s. 6d. to £44 per ton. If the improvement in trade makes the headway it is expected to make under the influence of a strong Constitutional Government, we may look for a greatly increased consumption of copper and a still further shrinkage in the available supplies. That copper will be much higher before the year is out there seems no reasonable room to doubt."

Surbiton.—At the last Town Council meeting the Electric Lighting Committee reported as follows: "We have received a notice from the Capital and Counties Electricity Supply Company, Limited, stating that they intend to apply before December 21 next to the Board of Trade for a provisional order to authorise the said company to supply electricity within the area of the jurisdiction of the Surbiton Urban District Council. We have directed the clerk to inform the company that the Council intend to light the district themselves under the order they have already obtained. We recommend that at least six firms should be invited to send in plans and specifications, with an estimate of the expense of lighting the district; and that if we require it we should be authorised to appoint some engineer of eminence to supervise and select the most eligible plans sent in by the firms who tender." The report was adopted, on the motion of Mr. Williams.

The Douglas Tramways.—The Tynwald Court Committee appointed to consider the petition of the Isle of Man Tramways Company and the Douglas Town Commissioners for leave to introduce a Bill to authorise the laying down and working of a tramway to the upper part of the town, and to confirm and approve a provisional agreement made between the Douglas Town Commissioners and the tramways company, met at Douglas on Tuesday, Deemster Gill presided. Evidence was given by Mr. J. Moore, civil engineer, Mr. William Mackenzie, tramway owner, and Mr. William Henry Andrews, secretary of the London Tramways Company, in favour of a cable system of tramways as opposed to any other form of traction, and agreed that the tramway company's offer of a minimum sum of £15,000 a year for the extension of the lease on the shore front for 21 years was a most satisfactory offer. At the conclusion of the evidence, the committee reserved their decision till Tuesday next.

Fulham.—The Electric Lighting Committee of the Fulham Vestry have reported to the Vestry that they considered there were reasonable grounds for supposing that electric lighting, in conjunction with a dust destructor, could be installed in the parish at a profit to the ratepayers. The Capital and Counties Electricity Supply Company having given notice of their intention to apply for an order to light the district by electricity, the committee reported that they considered that the Vestry would do well to keep the lighting in their own hands. Messrs. Kincaid, Waller, and Manville had therefore been asked whether they were willing to report, for a fee of not more than £50, whether the suggested installation could be carried out in such a manner as to prove a source of profit to the parish. The experts are to be asked what are the most striking features of the present leading systems of electric lighting systems of electric lighting combined with the utilisation of parish refuse.

New Mains.—The London County Council have approved of the following new electric lighting mains being laid: by the County of London and Brush Provincial Electric Lighting Company, Limited, in Garnault-place, in and across Exmouth-street, across Farringdon-road into Rosebery-avenue subway, and in Great Warner-street, Dorrington street, Clerkenwell-road, and part of Farringdon-road, under the County of London (North) Order of 1892; by the same company in Putney-hill, under the Wandsworth Order of 1892; and by the Westminster Electric Supply Corporation in Chapel-place and both sides of Chapel-mews. Notices were also received by the Council from the Vestry of Hampstead, under the Hampstead Order, 1892, of intention to lay mains in Inglewood-road and West End-lane; and from the Vestry of Islington, under the Islington Order, 1893, of intention to lay mains in Paradise-row. The respective vestries are the undertakers under the orders, and the Council has no power of approval or disapproval of works.

West African Telegraph Company.—The report of the directors for the 12 months ended December 31 last states that the Company's revenue for that period amounted to £64,761, against which £17,286 is charged for ordinary expenses and £13,473 for expenditure relating to repairs of cables, etc. After providing for income tax and revaluation of currency assets, there remains a balance of £33,058. From this balance there have been deducted £11,900 for interest on debentures and £11,766 for sinking fund, leaving £9,391, which has been carried to the general reserve fund. In a circular accompanying the report the directors state: "It will be seen that the sum of £9,391, net revenue on the year's working, has been placed to the credit of the reserve fund. This is simply replacing the amount taken from this fund last year on account of heavy repairs. We are now in a sound financial position. With respect to the year 1895, the result of the first six months' working justifies your directors in paying an interim dividend of 2s. per share, which is at the rate of 2 per cent. per annum, and will be payable on the 26th inst."

Yarmouth.—At the last Town Council meeting a letter was read from the Local Government Board, forwarding sanction to the Council borrowing on loan the sum of £17,500 for purposes of electric lighting, repayable in 25 years. The Electric Lighting Committee stated in their report that since their last meeting applications had been received from five customers for 178 lamps, making the total number of customers 92 for 4,700 lamps. The expenditure for the month had been £99. 8s. 4d. and the income £80. 0s. 8d., showing loss on the month's working of £19. 7s. 8d. Stores were required to the amount of £56. 9s. It was desired that the oil-feeding apparatus should be proceeded with. The cost of buildings, tanks, and works which could be carried out locally was £45, and about £60 was the cost of the apparatus from the manufacturers. This expenditure would be paid for out of the loan of £17,500, for which they now had the assent of the Local Government Board. The committee recommended the Council to order the stores and oil-feeding apparatus named in the above report. The report was adopted without discussion.

Scarborough.—The Lamp Sub-Committee, having considered the tender received from the Scarborough Electric Supply Company, Limited, for the lighting of certain streets in the borough with the electric light at a cost of £915. 5s., and also a report prepared by the borough surveyor as to the lighting of the same streets with gas at a cost of £349. 12s. 9d., it has been agreed that the matter should be referred to the Sanitary and Lighting Committee for consideration. At a later meeting of the whole committee the foregoing minutes were approved and confirmed and it was resolved that the proposal to light certain streets in the borough with the electric light could not be entertained at present. Mr. J. W. Woodall wrote stating that he had an offer from an exhibitor to find electric current for a 1,000 c.p. arc lamp to illuminate the exterior of the Fishery Exhibition building, and asking permission to erect other two lamps of 500 c.p. each on iron posts at least 20ft. high on the outer footpath side, or one lamp on the outside of the wall with reflectors, so that no direct light should be shown seawards. The permission was given with certain restrictions.

Aberystwith.—The Town Council have held a meeting at which the following letter was read: "Dear Sir,—Owing to circumstances over which I had no control I was compelled to shut off the electric light last night (July 5) at 10.15, but am pleased to say that I was enabled to light up again after 14 minutes' stoppage. The real cause of the stoppage was the outbreak of one of those complaints to which every dynamo machine is liable—viz., a slight fault in the construction of the machine, and one which often baffles the most expert until it shows itself. I shall be glad if you will inform your Corporation that I have remedied the defect, and that the same fault cannot possibly occur again. I much regret that this should have happened, occurring as it did at a time when the light was probably much needed.—Yours, W. J. Breach, chief electrician." The Finance Committee, in their report, recommended the erection of two additional electric light lamps; and, after some discussion, the recommendation was agreed to, and it was left to the committee to decide whether the lamps should be used in the winter in place of one or two on the Terrace.

Cardiff.—A meeting of the Lighting and Electrical Committee of the Town Council was held on Tuesday afternoon, at which the borough engineer, Mr. W. Harpur, submitted the estimate for the electric works and plant, which showed the estimated sum of £32,500 had been exceeded by £5,000, and he recommended that they apply for powers to borrow an additional £7,500 for the proposed extension and other purposes. He also submitted an estimate of the working expenses for the ensuing six months for the whole of the lighting department (including gas and electricity), which he put at £5,580. 10s., a sum almost identical with that of the last budget, which was £5,556. Mr. Harpur reported that at the request of the Mayor he had had an examination made at the corner of High-street, where Mr. S F. Walker had complained of corrosion setting up in the electric lighting mains, and he found the pipe indicated in as good a condition as when it was laid down. Mr. Ritches said it was only fair that this contradiction should be made known. Mr. Brain: Mr. Walker made a mistake. Mr. Harpur: He may have seen an old water or gas pipe.—The chief librarian at the free library has been instructed to obtain a sketch for electric fittings for the library.

Taunton.—The Electric Lighting Committee presented the following report at the last meeting of the Town Council: "Your committee have received tenders for supplying and fixing a main switchboard at the works. They recommend, provided Messrs. Newton will enter into a contract to carry on the work in accordance with the specification and conditions prepared by Dr. Fleming, that their tender be accepted for the sum of £390. Your committee recommend that tenders be invited from the British Thomson-Houston, Limited, the Westinghouse Company, Limited, Siemens Bros., Limited, Crompton and Co., Limited, and

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Messrs. Johnson and Phillips for an alternator and exciter for the works, in accordance with a specification prepared by Dr. Fleming." The report was adopted on the motion of Councillor Potter, who explained that Dr. Fleming had advised the committee again and again not to be influenced by lowness of price when purchasing electric light plant. Dr. Fleming had pointed out that although one machine might be lower in price than another, it might turn out to be dearer in the long run than a machine that cost more to purchase, simply because of the loss of generative power. The Council might therefore rest assured that Dr. Fleming, in recommending the purchase of Messrs. Newton's switchboard, had taken this point into consideration and it was consequently a source of great gratification to the Electric Lighting Committee to be able to recommend the Council to adopt Messrs. Newton's apparatus, especially as it was not only deemed by Dr. Fleming to be the most suitable for the purpose for which it was required, but was also the lowest in price.

Loans.—Upon the recommendation of the Finance Committee, the London County Council on Tuesday agreed to lend the Hammersmith Vestry £7,000 for the purchase of land upon which to construct an electric lighting station. The Council on April 2 last agreed to advance the Vestry of Shoreditch £2 000, repayable within 54 years, £1,070 of which was ascribed to the street improvement in Bowling-green-walk, and £930 for land for the electric lighting station. The loan has not been taken up, as the Vestry wishes it to be increased by a further sum of £687. It appears that of this additional sum £107 is wanted for the acquisition of the freehold and other interests in 6, Bowling-green-walk, and the balance, £580, for purchase of the leasehold interest in 25, Coronet-street. The Finance Committee recommended: "That, subject to the Council hereafter giving its written consent under seal to the borrowing, and subject to all necessary consents and evidence being furnished to the satisfaction of the solicitor of the Council, the application of the Vestry of Shoreditch for a loan of £687, to defray the cost of purchasing the interests in 6, Bowling-green-walk and 25, Coronet-street, to provide an enlargement of the site for an electric lighting station, be granted, on condition that the loan be taken up at once, interest being charged thereon at the rate of £3. 10s. per cent. per annum, payable quarterly on January 31, April 30, July 31, and October 31 in each year, and the principal being repaid by equal annual instalments on each April 30 as to £107 within a period of 54 years and as to £580 within 30 years; that it be referred to the solicitor to take the necessary measures for completing the loan, and that the amount be advanced out of the consolidated loans fund." This was approved of.

Chili Telephone Company, Limited.—The report of this Company for the year ended March 31 states that a small addition to the tariff made in October caused some subscribers to withdraw, but others have been connected, making the aggregate number at all centres 4,015 at the end of the 12 months, as compared with 3,987 at the beginning, or a gain of 28. The gross revenue from all sources was 555,551dol., as compared with 504,188dol., an increase of 51,363dol. Owing to the additional expense incurred by reconstructing some of the trunk lines which were in bad condition, the expenditure in Chili was exceptional, amounting to 364,477dol, as against 324,536dol.—an increase of 39,941dol. The net income in Chili from all sources was 191,074dol, as against 179,652dol.—an increase of 11,422dol. The average rate of exchange for the year was 13·61d., as compared with 13·96d., giving a fall of 0·35d. Converted into sterling at these rates, the Chilian figures are £10,835, against £10,448—an increase of £387. The liquid assets and liabilities in Chili on March 31 were valued at 16¾d, the current rate of exchange on that day, as compared with 13d., at which they were valued in the previous year. The increase in the value of the liquid assets over liabilities in Chili, due to this rise in exchange amounts to £2,751, which has been carried to the reserve fund, raising it to £11,852 The expenditure in London is £116 less. The net profit of the whole business was £6,013, as compared with £3,528, an increase of £2,485. The directors recommend the payment of a dividend of 2s. 6d. per share, being at the rate of 2½ per cent. per annum free of income tax, leaving £513 to be carried forward. The capital outlay in sterling was £3,845. The general manager in Chili reports that prospects are encouraging, and affairs improving in every direction

Yorkshire House-to-House Electricity Company, Limited.—The directors have issued the following prospectus to the shareholders: "In view of the increasing demand for electricity in the city of Leeds, the directors have decided upon a considerable extension of the Company's plant and buildings, to meet the anticipated requirements for the winter of 1896. The existing buildings being now filled with plant, the directors are considering plans for a new engine and boiler house on the remaining land of the Company, and propose to instal, in the first instance, additional plant of at least 1 000 i.h.p. These extensions will involve a large expenditure, and the directors have therefore decided to raise the required capital by the issue of shares unallotted. The 9,900 ordinary shares still unissued are now offered at par (£5) to the shareholders, who may apply for any number not exceeding their present holdings respectively. Should any shares remain unapplied for they may be disposed of as the directors determine. A deposit of 10s. per share is payable on application, and a further sum of 10s. per share on allotment. No further call will be made payable before January 1, 1896. Subsequent calls will not be made at intervals of less than three months, and no call will exceed £1 per share. As the Company's ordinary shares have been recently dealt in at a premium, shareholders making application will obtain the advantage of any increase in the market value. Forms of application and copies of the original prospectus may be obtained from the secretary. The contracts and documents referred to in the prospectus may be inspected at the offices of the Company. Applicants for shares will be considered to have notice of any other contracts and to have waived further compliance with Section 38 of the Companies' Act 1867, and allotments will only be made on this footing. Applications for shares must be made on or before August 1, 1895."

Electric Plant.—Messrs. Ernest Scott and Mountain, Limited, Close Works, Newcastle-on-Tyne, have been entrusted with the contract for the electric lighting of Grey Towers, the residence of Mr. A. J. Dorman. This installation will be of a particularly complete character when finished, and will consist of Cornish boiler 18ft. long by 5ft. 6in. diameter, supplying steam to one of Scott and Mountain's vertical high-speed steam-engines, the engine driving on to an Admiralty-type shunt-wound dynamo feeding accumulators capable of storing current for 225 lamps. The installation will consist of about 250 lamps in all throughout the house and stables. In addition to the electric lighting, Mr. Dorman has decided to drive the laundry machinery by electric motors, and the pump for supplying water to the house will be driven in a similar manner. It is further contemplated carrying the cables to the home farm, where the farm machinery will be driven by electric motors. Messrs. Scott and Mountain are extremely busy in their electrical department, and also in general engineering work. In the former department they have in hand a large electric pumping plant for the Lothian Coal Company, for their Newbattle Collieries Dalkeith, N.B.; electric haulage plant for the Hickleton Main Colliery; together with complete coal cutting plants for the Nostell Colliery, Wakefield, also the Roughrigg Colliery, in Scotland. In the engineering department they are equally well employed, being busy with electric light engines, including an engine capable of giving 200 effective horse-power for the Nostell Colliery. The firm have also a considerable number of their improved type of feed, fire, and bilge pumps in hand for H.M.S. "Venus," "Diana," and "Mars." The Admiralty have recently decided to adopt electrically-driven fans for the ventilation of warships, eight of the firm's improved fans being in hand for H.M.S. "Venus" and "Diana," and H.M.S. "Juno" and "Doris."

National Telephone Company.—The report of the directors for the half-year ended June 30 last states that the income accrued in respect of the business of the half-year amounts to £393,855 as compared with £359,891 for the corresponding period of 1894, being an increase of £33,963. The working expenses for the half-year amount to £206,888, as compared with £187,089 for the corresponding period of 1894, being an increase of £19,799. The net result for the half-year (after deducting the Post Office royalties, amounting to £35,263) is a profit balance of £151,703, as compared with £140 533 for the corresponding period of 1894, being an increase of £11,169. The rentals carried forward for unexpired terms of running contracts amount to £390,978, as compared with £345,358 at the corresponding period of 1894, or an increase of £45,619. Out of the available balance of £122,767 shown by the net revenue account the Board recommends the payment of a dividend at the rate of 6 per cent. per annum, less income tax, on the first and second preference shares, 5 per cent per annum, less income tax, on the third preference shares, and 5 per cent. per annum, free of income tax, on the ordinary shares. The Board also proposes to transfer £35,000 to the reserve fund, and to carry forward the balance of £3,288 The draft of the formal agreement with the Post Office for the acquisition by the Department of the Company's trunk lines having been laid upon the table of the House of Commons, in accordance with the promise of the Postmaster-General, the preliminary agreement requisite to give effect to the arrangements was duly executed and completed on March 15 last. The difficult and somewhat complicated details connected with the transfer of the Company's trunk lines are approaching completion, and payment of the purchase-money, now in process of being ascertained, may be expected shortly. A Parliamentary Committee on telephone questions has had during the past session many sittings, and taken much evidence but has not made a final report. The enquiry stands over till the new Parliament assembles, when it may be hoped the questions submitted to the committee will be speedily determined.

Elmore's Foreign and Colonial Copper Company.—A correspondent of the *Financial News* writes: "The directors of this Company have recently invited the shareholders to subscribe for £7,500 7 per cent. first debentures, secured upon a portion of the Company's securities, the nominal value of which portion is about £87,000. The money is required 'for the purpose of wiping out the remaining few liabilities of the Company, and to enable the Board to deal to the best advantage with the unsold patents and the securities they hold.' The directors further add that 'the security offered is ample; the rate of interest and the bonus on redemption in three years are high' It seems, however, that the response of the shareholders, so far, has not been satisfactory, and an urgent appeal is again being made by the directors for subscriptions *pro rata*. Now, it appears to me that our directors can scarcely be surprised that the priority holders, at least, are somewhat reluctant in subscribing after the treatment which they have received in the past. When the prospectus of the Company was issued it was distinctly and emphatically stated in leading type that the priority holders were to receive the return of the par value of their shares (£5), together with a premium of 100 per cent., out of the first profits of the Company. The £5 was returned out of part of the profits on the sale of the French and German patents; but the whole of the cash profits

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(some £45,000) made by the sale of the American and Canadian patents were quietly handed over as a loan to the French company, instead of being returned to the priority holders, in accordance with the terms of the prospectus. Not only was this done without the consent of the priority holders (except, perhaps, a few privately consulted), but without first securing sufficient support from the French shareholders to render that loan efficacious and satisfactory. And what is the result? This cash loan of over £40,000 has virtually dwindled down to so poor a security that the directors cannot apparently raise even £7,500 upon it to clear off their liabilities. When it is further considered that according to our last balance sheet the par value of the securities held by the Company amounted to over £160,000, apart from the value of the unsold patents, it is indeed a sarcasm on the past management of the Company to find these liabilities of some £8,000 a very pressing difficulty. Such results as these are not calculated to encourage subscriptions, and if money has to be raised in order to avoid the sale of securities at depreciated prices especially now, 'when,' as the directors say, 'the Company will shortly be able to deal with its assets in a way which cannot fail to be satisfactory to the shareholders,' the call should be upon the holders of founders' shares, to whom the reversion of future profits will chiefly accrue. Clearly, from what has been stated above, the priority holders have virtually handed over already (or it has been done in spite of them) a cash sum equal to a return of £3 per share. Have the founders done as much?"

Sydney Electric Tramway.—We have received the report of the New South Wales Department of Public Works for the year 1893-4, in which a description is given of the Military-road electric tramway, Sydney: "The generating plant of the Military-road consists of a Westinghouse compound engine, with 9in. and 14in. cylinders, taking steam at 400lb. to 110lb. from the main boilers, and driving by belt a Thomson-Houston generator at 900 revolutions, giving 500 to 550 volts. The line wire is of hand-drawn copper, 0·324in. diameter, and the total resistance of the circuit of five miles is 1·3 to 1·7 ohm, according to the weather, the extremes being in very wet and long-continued dry. The insulation of the line is remarkably high, being upwards of one megohm per mile. Fluid insulators are used. There are no feeders or auxiliary insulated conductors, but at the opposite end of the line to the power station is a small accumulator-house, containing a battery of 220 Planté cells of the simplest possible description, each having about 14 square feet of active surface. These cells are cylindrical, entirely of sheet lead, the outer cylinder being also the containing vessel, and are 12in. diameter by 10in. high. They were electrically formed solely by a few reversals of the current when first set up, and since then they have been twice reversed after long periods. The battery will discharge up to 60 or 70 amperes, and already holds sufficient to drive a car home from any part of the line in case of the power being cut off at the station. The capacity will increase with use, and, as far as can be seen, they are practically indestructible. But the great value of the accumulators consists in the help they give to the power plant by supplying the sudden drafts made upon the latter, either in starting the cars or in running up steep gradients, and so enabling the line not only to be worked economically without feeders, but with comparatively small engine power. During the periods when the cars are standing or going down hill, the power is being stored by the accumulators. The motors are of the smallest Thomson-Houston type, double reduction, with one exception: this is a single-reduction motor of 30 h.p., and the gears run in oil in dust-proof casing. Mr. Justin M'Sweeney was a successful tenderer for the extension along Military-road, North Sydney. Work was commenced in October, 1892, but owing to the question of motive power not having been decided upon was not opened for traffic until September 16, 1893, although the line had been practically completed for some months previous. This extension, which is two miles eleven chains in length, single track, joins the cable tramway at the intersection of Miller and Falcon streets, and thence along the Military-road to its junction with the Spit-road. The motive power adopted was electricity, the plant which had been previously working the Waverley-Randwick extension being transferred to North Shore, and located in the cable tramway power-house. The work carried out by this branch in connection with the electric system consisted of the supply and erection of a third boiler by Messrs. Hudson Bros., the alterations to power and car house were carried out by Messrs. Grant and Matheson, and the construction of the junction at the intersection of Miller and Falcon streets by Mr. Justin M'Sweeney. The amount expended on the works was £1,591. The amount of Mr. Justin M'Sweeney's contract for the construction of the permanent way was £6,053."

Windsor.—The Urban District Council have held a meeting at which the following appeared on the agenda: "Alderman Dyson to ask the chairman of the Electric Lighting Committee how far the question of producing the electric light by water power for the use of the town has been considered, and what progress has been made in the subject generally; and, further (the provisional order being assured), when will the all-important question of who shall carry out the scheme—the Corporation for the ratepayers, or the ratepayers for themselves—be considered?" Alderman Dewe, in reply, made a statement as follows: The matter was in the hands of Mr. Medhurst, and the committee were awaiting a report from him. There had been no loss of time. On June 2 a letter was received from Mr. Medhurst asking for information on behalf of his client, Mr. Liardet. He (Mr. Dewe) declined to take the responsibility of authorising the information to be sent, and on June 5 directed a meeting of the committee to be convened. On June 10 he received a letter from Mr. Medhurst complaining of some little delay in sending the information; the committee met on the 11th, when the following resolution was passed: "That the town clerk be authorised to write to Mr. Medhurst and ask him, first of all, to obtain a letter from his client indemnifying the Council against any expense unless the scheme is carried out, and that on the receipt of such letter the required information be furnished." On June 14 a copy of the resolution was sent to Mr. Medhurst; on June 17, Mr. Medhurst replied that he would at once write to Mr. Liardet for the letter required, and send the original to the town clerk, and would keep a copy. On July 2, a letter was received from Mr. Medhurst enclosing a letter from Mr. Liardet; on July 3, a plan was sent, and the surveyor witten to to send the other particulars. These particulars were now in the hands of Mr. Medhurst and Mr. Liardet, and directly the committee heard from them they would meet and consider Alderman Dyson: What has been done with regard to the water power? Alderman Dewe: I can only say that it is under the consideration of Mr. Medhurst. We are to have a general report not only on the best means of supplying light and water power, but a refuse destructor. Councillor Burt said Alderman Dyson must have felt obliged to the chairman of the Electric Lighting Committee for his courtesy in answering him so explicitly. Much seemed to have taken place since the last meeting of the committee. In Alderman Dewe's statement there was much information of which the committee should be cognisant. Was it advisable to make known to the Council general information of that kind before it came to the committee? He meant the letter received on July 4. The Deputy Town Clerk informed the Council that the electric lighting order granted to the Council by the Board of Trade had now become an Act of Parliament. It was passed among other unopposed Bills. The Council could set to work to carry out the supply of electric light to the town of Windsor, or pass resolutions empowering other people to supply it. Councillor Clarke: What was the cost of getting the order passed? The Deputy Town Clerk: I am not in a position to say precisely, but it will not exceed what was estimated—£250. Alderman Dyson said he had to thank Alderman Dewe for the information he had given him and the trouble he had taken to obtain it. He thought his question would show his anxiety that the work should be proceeded with The sooner the Council, having obtained the order, buckled to, the better it would be.

Harrow.—Plans of an electric light station in West-street, near the entrance to the Church Fields, were submitted to the District Council at their last meeting and approved. The clerk read the following letter: "To the chairman and members of the Harrow-on-the-Hill Urban District Council, successors to the Harrow Local Board,—We, the undersigned, Rookes Evelyn Bell Crompton and William Charles Cloete Hawtayne, hereby notify to you that we name the Harrow Electric Light and Power Company, Limited, as our nominees under the agreement of December 28, 1894, between the Harrow Local Board and ourselves for the transfer of the Harrow Electric Lighting Order, 1894. And we hereby request you to advertise and deposit the draft deed annexed to the said agreement, and in due course submit the same to the Board of Trade for their approval as required by the fifty-ninth section of the said order. At the same time we beg to hand you 20 printed copies of the draft deed for depositing and supplying to persons requiring the same.—(Signed) R. E. Crompton and W. C. C. Hawtayne." Mr. Saunders complained that they were giving the company the monopoly, whereas if they had gone to the Board of Trade for the order themselves the monopoly would not have been given to them. Could any of them, with the interests of the ratepayers at heart, really create a monopoly for 20 years? The commodity was certain to go down in price, but they would have no ghost of a chance of a reduction in Harrow. Some gentlemen had said they might go to the Board of Trade for a reduction, but that was out of the question, as the company by the deed were to be allowed to take 7 per cent. on their outlay. Where was there an electric light company paying 7 per cent.? It might go down to 2d. a unit in the next 20 years, but in Harrow they would have to keep on paying 8d. per unit That was not a proposal which anybody in their senses would listen to for a moment. He was quite sure the ratepayers of Harrow would not do so. They were going to create this monopoly to benefit nine private consumers. He could not conceive anyone out of a lunatic asylum agreeing to it. The Council might, but they could not debar the ratepayers from signing a memorial which he was going to present. He understood Mr. Fisher was solicitor to the new company, but no man could serve two masters, and he should not act for gentlemen who were their opponents. It had been said that he wanted to choke off the light, but that was not so. What he was hostile to was an iniquitous monopoly. Let the company come to the Council for an annual license. He had no definite resolution to propose, but he wanted them not to appear to approve of the Local Board's action in transferring their order. Mr. Hawkins said there was one outside a lunatic asylum who was prepared to take his stand on the transfer, and that was himself. Mr. Saunders made the order of absolutely no use to the Local Board, and they did well to sell it and save the ratepayers any expense in the matter. The monopoly, as Mr. Saunders called it, would be to the benefit of the town. Dr. Williams suggested whether they were in order discussing a subject with no resolution before them. By dodging their standing orders members who had already spoken could speak again, and that was not fair. Mr. Hawkins said the only business-like step was to grant the transfer, and he moved "that it be granted." Mr. Bradley Smith seconded the motion. Mr. Saunders moved as an amendment, "That Messrs Crompton and Hawtayne be informed that the Council are not prepared to go on with the contract." Mr.

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Strange seconded the amendment, Messrs. Saunders and Strange voting for it, and the chairman, Dr. Williams, Messrs. Strickland, Bradley Smith, and Hawkins against. Messrs. Dell and Clowes did not vote. On Mr. Hawkins's original motion being put, there voted for it the chairman, Dr. Williams, Messrs. Strickland, Bradley Smith, and Hawkins, and against it Messrs. Saunders and Strange. Messrs. Dell and Clowes again did not vote.

PROVISIONAL PATENTS, 1895.

JULY 8.

13164. **Improvements in alternating-current dynamos.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Maschinenfabrik Oerlikon, Switzerland.)

13168. **Improvements in electrical contact-making devices.** Richard Myers, 323, High Holborn, London.

JULY 9.

13205. **Improvements in electrical transmission of energy for signalling.** Michael Idvorsky Pupin, 46, Lincoln's-inn-fields, London. (Complete specification.)

13207. **Improvements connected with electric arc lamps.** Albert Cooper Seibold, Edgar Olcott Clark, and William Sowdon, 55, Chancery-lane, London. (Complete specification.)

13255. **Improvements in apparatus for the electrolysis of oxides, salts, and other chemical compounds.** Joseph Baxeres Torres, 17, St. Anne's-court, Wardour-street, London.

3274. **An improved arrangement for telephonic apparatus adapted to only register the conversations really held.** Franz Quatram and Ernst Hildebrandt, 18, Buckingham-street, Strand, London.

JULY 10.

13285. **Improvements in electrical switches.** Martin Rohmann, Box 94, Johannesburg, South Africa.

13303. **Improvements connected with arc lamps.** Ernest Albert Pellet, 37, Cursitor-street, Chancery-lane, London.

13312. **A rain-making contrivance to be used in conjunction with the barometer, hydrometer, electrometer, etc., under Government control by wire (telegraph).** Hans Peder Madsen, 43, Upper Marylebone street, London.

JULY 11.

13348. **Improved methods of distributing power by electricity.** Frederick Henry Royce and Ernest Alexander Claremont, Electron, Cavendish-road, Chorlton-cum-Hardy. (Complete specification.)

3380. **Improved electric lighting system for railway vehicles and dynamo therefor.** Morris Moskowitz, Leon Daniel Adler, Abraham Sanford Adler, and Theodore Walter Myers, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13388. **Improvements in electric arc lamps.** James Devonshire, 70, Chancery-lane, London. (Elihu Thomson and Charles E. Harthan, United States.) (Complete specification.)

13389. **Improvements in methods of and means for regulating the speed of continuous-current motors.** James Devonshire, 70, Chancery-lane, London. (Merle J. Wightman, United States.) (Complete specification.)

JULY 12.

13404. **Improvements in dynamo-electric machinery.** Frederick Henry Royce and Ernest Alexander Claremont, Electron, Cavendish-road, Chorlton-cum-Hardy. (Complete specification.)

13405. **Improvements in and relating to electric telephone systems.** Alexander Marr, 70, Market-street, Manchester. (Complete specification.)

13411. **Improved methods of distributing power by electricity.** Frederick Henry Royce and Ernest Alexander Claremont, Electron, Cavendish-road, Chorlton-cum-Hardy. (Complete specification.)

13416. **Improvements in electric lamps for stage lighting.** Austin Walters, 4, St. Ann's-square, Manchester. (Complete specification.)

13426. **An electric polishing machine.** Carl Oppermann, 2, Wynyatt-street, Clerkenwell, London.

13434. **Improvements in the electrolytical production of zinc from its ores and apparatus therefor.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.) (Complete specification.)

13436. **Improvements in electric light suspension fittings.** Leslie Bradley Miller, 2, Gray's-inn-road, London.

13438. **Improvements in or relating to telephone switchboards and pushes or calling devices connected therewith.** Jakob Stamm, 46, Lincoln's-inn-fields, London. (Complete specification.)

13444. **Improvements in electrical heating apparatus.** Octavius March, 40, Chancery-lane, London.

13459. **Improvements in the manufacture and production of electric cables or conductors.** George Edward Heyl, 47, Lincoln's-inn-fields, London.

13472. **An improved electric lighting system for road and railway vehicles.** Nicolas Gleboff, 45, Southampton-buildings, Chancery-lane, London.

18274A. **An improvement in electric arc lamps.** James Brockie, 28, Southampton-buildings, Chancery lane, London. (Date claimed under Patents Rule 19, September 26, 1894.

JULY 13.

13483. **Improvements in dynamo-electric and electro-dynamic machines.** Charles Raleigh, 191, Fleet-street, London.

13495. **An improved electrically-illuminated curtain or drop for theatrical purposes.** William Holland, 5, John Dalton-street, Manchester.

13530. **Improvements in telephones.** Anton Hamm, Gergely Blank, Victor Brandt, and Gyula Körmendy, 28, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1894.

835. **Electrolytic apparatus.** Hargreaves and Bird. (Second edition.)

15282. **Ploughing by electricity.** Brutschke and Schimpff.

15617. **Registering number of telephonic conversations.** Münch.

15816. **Telegraph apparatus for marine, etc., engines.** Douglas.

15843. **Telegraphic apparatus.** Boudet and Lacombe.

15858. **Electric railways, etc.** Claret and Wuilleumier.

18359. **Electric elevating mechanism.** Willcox. (Eisenwerk, late Nagel and Kaemp, Actien Gesellschaft.)

19176. **Telephone indicators.** Ericsson.

1895.

8049. **Electric alarm clocks.** Thompson. (Knapp and another.)

9132. **Electric ceiling and wall connectors.** Dorman and another.

9217. **Electric cut-outs.** Verity.

9547. **Attaching electric lamp to a cap.** Lake. (Rodriguez and another.)

10052. **Electric railway signals.** H. V. and H. C. Miller.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅛-5⅜
Brush Company, Ordinary	8	2¼-2½
—— Nom. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5⅛-5¼
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	16-17
—— 5 per cent. Debenture Stock	100	131-154
City and South London Railway, Consolidated Ordinary	100	42-44
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A 1-200 of £50	100	—
Electric Construction, Limited	2	⅞-1
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	2-2½
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	¾-1⅛
Elmore's Wire Company	2	1-1¼
Fowler-Waring Cables	5	⅛-¼
W. T. Henley's Telegraph Works, Ordinary	10	10½-11½
—— 7 per cent. Preference	10	14-15
—— 4½ per cent. Debentures	100	104-107
House-to-House Company, Ordinary	5	3½-4
—— 7 per cent. Preference	5	7⅛-7½
India Rubber and Gutta Percha Works	10	19-21 xd
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅜-7½
—— Pref.	—	—
Liverpool Overhead Railway	10	10 7/16-10 9/16
—— Pref.	10	14½-15½
—— 4 per cent. Mortgage Debentures of £100	100	110-112
London Electric	5	⅛-¼
Metropolitan Electric Supply	10	10½-11
—— 4½ per cent. First Mortgage Debenture Stock	100	116-119
National Telephone, Ordinary	5	5⅜-6
—— 6 per cent. Cum. First Pref.	10	16-17
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-6⅛
—— 3½ per cent. Deb. Stock	100	105-107
Notting Hill Company	10	8½-8⅝
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7-7½
—— £4½ shares	4½	5¾-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8-8½
—— 7 per cent. Pref.	5	9-9½
Swan United Ordinary	3	1⅞-2⅛
—— 4½ per cent. Debentures	100	104-107
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4⅜-4⅝
Westminster Electric Supply, Ordinary	5	7⅜-8⅛
Yorkshire House-to-House	5	5⅛-5⅜

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NOTES.

The Seel Patent.—It is reported from Berlin that a new company, with a capital of 1,000,000 marks, has been formed to exploit a fresh Seel incandescent lamp patent.

The Telephone in Turkey.—The Grand Turk has long resisted the introduction of the mysterious telephone into his dominions, but, if reports from Constantinople be true, the Sultan seems at last disposed to consent to the erection of a telephonic line between Stamboul and Sofia.

Late News.—The Department of Science and Art has just received information through the Foreign Office that an industrial exhibition is to be held next year at Berlin. Everybody knew this some years ago, but Government departments are notoriously slow in obtaining information.

Electricity in Zinc Production.—An item from Adelaide states that there has been a miniature boom in the shares of some Broken Hill mines known to contain sulphide ores, owing to the discovery by Mr. Ashcroft, electrician of the Proprietary mine, of a successful process of extracting the zinc by electrolysis.

The Black Sea-Baltic Canal.—In connection with the scheme for the construction of a canal from Riga, on the Baltic, to Cherson, on the Black Sea, it is proposed to utilise the water power which the various auxiliary rivers will yield on entering the canal for electric lighting, so that the canal can be navigated at night.

The Electric Light in Italy.—The delightful town of Eboli, or Evoli, 44 miles to the south-east of Naples, is to be electrically illuminated. Hydraulic power will be transmitted electrically from a neighbouring district, and the installation will consist of 100 16-c.p., 70 25-c.p., and 30 50-c.p. lamps. The rate to be charged to consumers will be one centesimo per candle per evening.

Electric Fireworks.—A system of electric fireworks which has recently been invented by a M. Champion is nightly attracting large crowds to the public garden in Angers—so our lively contemporary *L'Etincelle Electrique* (July 20) records. The spectacle is, it seems, varied by luminous electric fountains and by the electro-terpsichorean performances of a mysterious but apparently well-known personage called Loïe Fuller.

Moving with the Times.—In former days fortune-tellers used to think that they did enough when for a shilling or so they promised a young woman three husbands, but Mary Smith, of Manchester, is keeping up to date. She promised one of her visitors a dark young man as a husband, and also that she would be taken by him to a place where there would be a great many electric lights. This was cheap at half-a-crown.

Trans-African Telegraphy. — The Trans-African telegraph line is being pushed rapidly forward. If the transport service between the Shiré and Lake Nyassa does not prove too great a drawback, a cable is to be laid through the latter lake to the northernmost end, and thence the line will follow the Stevenson road to Tanganyika, where another cable service is projected, a land line joining Uganda with the lake.

Michigan Mining School.—We have received a prospectus of the Michigan Mining School, Houghton, Michigan, in which electrical engineering occupies a place. As illustrative of American methods, we may quote the following passage: "The degree of mining engineer will carry with it also the degree of bachelor of science, if the candidate for the degree of E.M. shall make application for the S.B. degree and pay the required fee."

Liverpool Engineering Society.—On Saturday a party of members paid a visit to the Lytham sewage works at the invitation of Dr. L. Fisher, J.P., chairman of the Urban District Council. Mr. Paterson, of the Hermite Company, explained that the system experimentally adopted at Lytham is the Hermite process. After an inspection of the electrical work, of the various manholes on the main sewer, and of the outfalls, the party were entertained by Mr. Alderman W. L. M'Clure, J.P.

Institution of Civil Engineers.—The Association of Yorkshire Students of the Institution of Civil Engineers paid a visit to the West Riding Collieries of Messrs. Pope and Pearson at Altofts on Saturday. The party afterwards proceeded to inspect the surface plant, special attention being given to the elaborate screens and to the coal-washing plant recently erected upon Baum's system. The air-compressing, electric lighting, and winding machinery were also inspected.

Electricity on the Stage.—A dance, entitled "Les Fleurs Electriques," is being given at the Tivoli, in the Strand, by the three Sisters Devereaux. The three lady dancers are covered with electric lamps to represent various coloured flowers. The lamps are worked from off the electric light mains, and are made to change colour with the movements of the dancers and the music, producing a very pleasing effect. The electrical work has been carried out by the Lithanode and General Electric Company, Limited, 64, Millbank-street, S.W.

Electric Organ.—The celestial organ presented to Westminster Abbey by Mr. A. D. Clarke is now set up in the triforium of the south transept, and at Sunday's service was played by Dr. Bridge. Though in all respects a separate organ, complete in itself, it forms part of the grand instrument in the choir. It is controlled from the same console, and may be used in conjunction with the great organ. The action is electric, connection being established by a cable 200ft. in length. Since the organ is not visible from the church below, and is separated from the organist by the full length of the building, the effect when the music breaks forth is very striking.

New Electric Tramway System.—German papers announce that Messrs. Schuckert and Co. have invented a new system of electric tramway traction, by which the disfigurement of the streets through overhead conductors is avoided. Between the rails, at intervals of about five yards, are placed small insulated contact-pins, let into the pavement, which offer no obstruction to the ordinary street traffic, and to which current is conveyed by conductors from the power station. The new system, it is stated, will prove to be much cheaper than the underground conduit method. Thus the German papers. The truth probably is that Messrs. Schuckert have acquired the patent rights for Germany of the Wheless system described in our last issue, page 76.

New Telegraph Instrument.—*Elettricità* of July 21 announces that an official, named Colonna, in the Central Post Office in Rome, has invented a telegraph instrument whose powers of rapid transmission are superior to those of existing apparatus, and which can replace with advantage the Wheatstone instrument that is at present used for the simultaneous dissemination of parliamentary reports to the most important telegraph offices in the kingdom and to the principal daily papers. The laborious translation of the signals which is associated with the Wheatstone system would, it is said, be obviated by the new instrument. The receiving part of the method would, it is added, require no special practice, and the system of transmission could be acquired in a short time.

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Prizes Given.—The French Société d'Encouragement pour l'Industrie Nationale has distributed its prizes for 1895. The premium of 2,000f., offered for an apparatus or an industrial process for rapidly measuring or estimating the insulation of the various parts of an electrical installation in operation, has not been awarded; but two consolation, or rather encouragement, prizes of 500f. have been granted to two electrical engineers, MM. Lartigue and Roux. In the list of medals bestowed for inventions or improvements in industrial arts, figures a silver medal won by M. Laffargue for his treatise on the electrical fitter. A silver medal has also been awarded M. Hillairet for the communication which he made to the society in April last on the subject of electric transmission in workshops.

Magnetic Declination.—The variations of magnetic declination, horizontal force and vertical force, and of earth currents, have been registered photographically at Greenwich Observatory. Increased magnetic activity was shown in the year 1894, and great disturbances occurred on July 20 and August 20; the spot of light of the vertical-force magnet on the former date, and the spots of light of the horizontal-force and vertical-force magnets on the latter, having passed beyond the range of the registering sheets for some hours. In these two cases the registers were supplemented by eye observations. In July and August the disturbance in the earth-current registers caused by the South London Electric Railway showed a great increase, which is presumably due to the experiments then being made in the use of motors on the carriages of the railway instead of separate locomotives.

Thermo-Electric Phenomena between Two Electrolytes.—M. Henri Bagard in the *Ann. Chim. Phys.* writes that in continuation of his researches he has determined the thermo-electric E.M.F. in the cases of a number of couples consisting of two electrolytes. The E.M.F. is in all cases, as with the metals, a function of the second degree of the temperature, and very frequently the existence of a neutral point was observed somewhere between 0deg. and 75deg., the limits of temperature of the experiments. In the case of two solutions of the same salt of different degrees of concentrations, the current always travels across the heated junction from the dilute to the concentrated solution. Becquerel's law of intermediate substances and the law of intermediate temperatures are found to hold good. There is a simultaneous inversion of the thermo-electric E.M.F. and of the Peltier effect at the point of contact of the two electrolytes, and an electrical transference of heat in these liquids.

Limits of Electrolysis.—M. Marcellin Berthelot, in *Ann. Chem. Phys.*, states that he has formerly shown by experiment that in the electrolysis of an alkali salt, of which neither the acid nor base is oxidised or reduced during the operation, the minimum E.M.F. necessary for electrolysis is the sum of two equivalent quantities—the one being the heat absorbed in the separation of the acid and the base in dilute solution, the other the heat of decomposition into oxygen and hydrogen of the water holding the substance in solution. In the case, for instance, of potassium sulphate in dilute solution the sum of the two quantities of heat is $15{\cdot}7 + 34{\cdot}5 = 50{\cdot}2$ cal., when one gramme of hydrogen is liberated. This is equivalent to 2·20 volts, a number which Le Blanc has obtained by direct observation. Other results are quoted in support of the above law, which the author maintains as an empirical law, independent of any hypothesis regarding the condition of the dissolved salts in solution.

Influence of Magnetism on Chemical Action. Mr. F. A. Wolff, jun., in the *American Chemical Journal* states that in 1881 Remsen noticed that when copper is deposited from a solution of copper sulphate on a plate of iron placed on the poles of a magnet, it is arranged in ridges round the poles which are at right angles to the lines of force, and consequently coincident with the lines marking the equipotential surfaces. The outlines of the poles of the magnets are always sharply defined on the plate, as along these lines a portion of the iron of greater or less width is left unacted on. The author has investigated these phenomena, and his results and conclusions are contained in this paper. The absence of deposit over the outlines of the pole is not due to any direct influence of magnetism on chemical action, but to the accumulation of the iron salts formed in the reaction about those parts, and to the electric currents arising therefrom. The fact that the deposit is thickest immediately adjoining the protected region also finds its explanation in the electrolysis accompanying these currents. The deposition in ridges is not due to any direct influence of magnetism on chemical action, and is not directly due to the voltaic currents in the liquid. Copper is deposited in ridges on both magnetic and non-magnetic metal when a solution of copper sulphate is allowed to flow over them and the ridges are arranged along the lines of flow. The deposition in ridges when copper is deposited on iron in a magnetic field may be due to similar action.

Another.—The latest recruit to the already fairly serried ranks of electrical journalism in the United States is "*The Electrical Journal*: An Illustrated Review of the Industrial Applications of Electricity, Gas, and Power." As is usual with fresh ventures, our new Yankee cousin defends the inception of its being—and it does so in this fashion: "It is not altogether an uninteresting diversion to see three leading electrical papers chafing over the time-worn moot-point of venerableness, as from information at hand it would appear unquestionable that our esteemed prototype, the *Electrical Engineer*, is really the 'oldest' publication, as it claims, and that our newsy friend, the *Electrical Review*, is entitled to the distinction of being the 'oldest weekly.' As for the 'pioneer' journal, Webster defines the word as expressing 'one who goes before to remove obstructions or prepare the way for another,' or, in plainer terms, a pioneer is one who steps aside that another may pass on. It is advisable, then, if there must be a controversy, that it be confined to the journals named, or the third must either alter its plea or stand convicted on its own evidence. The *Electrical Journal* rests content in the knowledge that no one can dispute the claim that to-day it stands as the 'newest' electrical publication in America, if not in the world, and here, again, the same authority sapiently defines the word 'new' as 'recent, fresh, modern.' Clearly, then, the motto of the *Electrical Journal* shall be: 'The newest electrical publication in America.'" We have no intention to contest the modest claim of our young dime contemporary, which, by the way, is published in the Golden West, at 'Frisco.

Compounding Dynamos for Armature Reaction. Prof. Elihu Thomson read a paper on this subject at the Niagara meeting of the American Institute of Electrical Engineers, in which he described a type of dynamo not claimed to have any commercial importance, except, perhaps, in very special cases, but interesting in several respects. The machine may briefly be described as a four-pole dynamo with windings on only two opposite poles. Under no load the magnetic flux tends to pass entirely through the armature between the "live" poles, while with load the distortion of the field causes some of the flux to be diverted through the "dead" poles. By properly choosing

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the position and spread of the "dead" poles in relation to the wound or excited poles, and adjusting the magnetomotive force of the initial field relatively to the turns on the armature and the speed of driving, the effect of compounding or over-compounding may easily be obtained. The paper contains curves giving the results of experiments under different loads, showing that a large range in compounding is possible. A feature of the machine which developed itself when carbon brushes were used was that even at heavy loads the brushes could be set back from their maximum position, or true diameter of commutation, and that the movement was attended with little, if any, increase of spark, while the potential steadily went down. It was thus easily possible to adjust the potential by a backward movement of the brushes in the space between the unwound and wound poles, while the slight sparking under the carbon brushes was not increased thereby.

Thermo-Electric Properties of Platinoid and Manganin.—Mr. Benjamin O. Pierce, in the *American Journal of Science*, states that he has had occasion to determine the thermo-electric relations of copper to such platinoid and manganin as are to be obtained in the market. The nature of the results will be seen from the following table. The current passes across the hot junction from the first-named metal to the second; the E.M.F. is measured in microvolts.

Temperatures of the junctions.	E.M.F. Copper *v.* manganin.	E.M.F. Platinoid *v.* copper.
0° and 10°	4·3	189
0 „ 20	9·2	379
0 „ 30	14·1	572
0 „ 40	19·6	769
0 „ 50	25·7	971
0 „ 60	32·6	1,179
0 „ 70	40·2	1,391
0 „ 80	48·1	1,609
0 „ 90	56·4	1,834
0 „ 100	64·9	2,063

The results vary with the thickness of the wires used and the annealing of the metals, but the E.M.F. of no one of the manganin-copper combinations experimented on was greater than about one-seventh that of the weakest of the platinoid-copper combinations under similar circumstances. Hard-drawn manganin wire can be used with advantage as a slide wire, since accidental heating does not alter its resistance appreciably, and the thermo-electric effects at the junctions of the slider would be insensible.

Institution of Mechanical Engineers. — The summer meeting of this institution will be held in Glasgow from Tuesday, 30th inst., till Friday, August 2, under the presidency of Prof. A. B. W. Kennedy, when the following papers will be read: "Hydraulic Stoking Machinery and Labour-Saving Appliances in Modern Gasworks," by Mr. Andrew S. Biggart, of Glasgow; "Notes on Hydraulic Power Supply in Towns: Glasgow, Manchester, Buenos Ayres, etc.," by Mr. Edward B. Ellington, of London; "Recent Engineering Improvements of the Clyde Navigation," by Mr. James Deas, engineer of the Clyde Navigation; "Notes on Modern Steelworks Machinery," by Mr. James Riley, of Glasgow; "Telemeters and Range-Finders for Naval and other Purposes," by Profs. Barr and Stroud; and "The Electric Lighting of Edinburgh," by Mr. Henry R. J. Burstall, of London. Visits will be paid to the Glasgow waterworks, Milngavie; Glasgow sewage works; Dalmarnock Ironworks; the works of the London and Glasgow Engineering and Iron Shipbuilding Company; the Fairfield Shipbuilding and Engineering Company; Messrs. Alex. Stephen and Sons' works, Linthouse; Dawsholm gasworks, Maryhill; Messrs. Neilson's Hyde Park Locomotive Works; Messrs. Sharp, Stewart, and Co.'s Atlas Works; Caledonian Railway Works, St. Rollox; North British Railway Works, Cowlairs; Messrs. Dübs's Glasgow Locomotive Works; Messrs. Alley and MacLellan's Sentinel Engine Works; the works of the Glasgow Iron and Steel Company; and the works of the Summerlee and Mossend Iron and Steel Company. On Saturday, August 3, the Edinburgh Corporation electric lighting station will be open to the visit of members. Among other works in Glasgow and the neighbourhood which will be open to members are those of Messrs. Mavor and Coulson, electrical engineers, Bridgeton Cross.

Cables.—The current number of the *Strand Magazine* contains a popular article by Mr. William G. Fitzgerald on "The Romance of our News Supply," in which he says: "The enemies of the cable are many and various. Sometimes a shark will bite at it savagely, leaving a few teeth in the coating as a memento of the encounter. During repairing operations in the Red Sea, the grapnels brought up a whale's skeleton weighing a ton or so. Then there are ships' anchors, submarine volcanoes, erratic currents, and continuous friction to contend with. The most successful and persistent enemy, however, was until recently the teredo boring worm. Even the teredo worm has now been baffled by the use of brass ribbon. The fact of a breakage is very easily discovered, but the way in which the spot is localised is simply marvellous. I cannot possibly describe the technical routine; let it suffice to say that the galvanometer test is applied, and then a cable-ship is despatched to within perhaps a few hundred yards of the actual breakage, when she uses her grapnels until the broken lengths are brought up. Before the final splice is made, messages are sent from the ship in mid-ocean to the nearest shore station. On certain occasions cable messages are interpreted at the receiving station by means of a brilliant spark which plays along a scale; but almost every message flashed from continent to continent is now recorded by that wondrous instrument known as the siphon recorder invented by Lord Kelvin. The principal parts of this instrument are a light rectangular coil of silk-covered wire and a powerful magnet. The coil is suspended between the poles of the magnet, so that when excited by the electric current from the cable it swings on a vertical axis. Its movements are recorded on a paper ribbon drawn at a uniform speed before the point of a fine glass siphon no thicker than a human hair, which conducts a stream of ink from a reservoir on to the paper ribbon. The marking end of the ribbon responds to and multiplies every movement of the coil, leaving on the ribbon an ink trail which is an exact and permanent record of the movements of the coil under the influence of the currents from the cable, but which the uninitiated might mistake for the trail of a partially-disabled bluebottle that had only just escaped an inky grave. The siphon records from 250 to 300 letters per minute."

Utilisation of the Nile.—A syndicate of American engineers and capitalists has been formed to utilise the water power in the North-East Fayoum, 30 miles south of Cairo. A branch of the great canal, the Bahr Jusuf, or river of Joseph, which now supplies the Fayoum with water, follows a deep ravine down to the Lake El-Qerun. The total difference between the Nile and the lake is about 220ft. It is calculated that by reopening the ancient canal, the Bahr Wardan, a fall can be obtained, without any considerable expanse for excavation, which would give an effective head of 160ft. The present flood discharge of the Bahr Jusuf is 2,863ft. per second, and the minimum discharge is 409ft. per second. The evaporating surface of

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the lake, which is about 130ft. below the Mediterranean, is 78 square miles, and the evaporation is calculated at 98in. per year. There is no appreciable rainfall. This scheme, which is due to Mr. Cope-Whitehouse, forms part of his project for the utilisation of the reservoir basins—the Lulu and Raiyan—to the south. He proposes to supplement the minimum available summer supply by water drawn from his reservoirs, and to provide against the rise of the lake by diverting a portion of the discharge during the flood into the reservoirs. The chief engineer of the General Electric Company has submitted a proposal to the Egyptian Government through the Department of State in Washington. The large number of American tourists estimated as exceeding last year 2,500 persons—largely composed of men of business activity—has awakened interest in the United States as to a possible opening in Egypt for American capital and enterprise. It is proposed to establish a trolley line between Medinet-el-Fayoum and Gizeh-Cairo; but plans have also been drawn up for a new town to be called Azizieh, whose favourable sanitary conditions would, it is believed, speedily attract a population sufficient to make it one of the chief manufacturing centres of the world for cotton goods. French political support is being sought to overcome administrative inertia. This scheme does not seem to be entirely dissimilar to that of the French engineer which we described in our issue of June 21, p. 702.

South Staffordshire Institute.—Last week about twenty of the members of the South Staffordshire and East Worcestershire Institute of Mining Engineers paid a visit to the James Bridge steelworks of Messrs. F. H. Lloyd and Co., and the generating station of the South Staffordshire Tramway Company. The party assembled at the James Bridge railway station, and were thence personally conducted to the works of the first-named company by Mr. J. W. Hall and Mr. J. Heming, two of the directors, who, in the fullest manner, explained all the processes. Afterwards the party passed on in a special car to the generating station, under the guidance of Mr. A. Dickinson, engineer and manager. There they found three compound horizontal engines, with 10½in. high and 20in. low pressure cylinders, fitted with Corliss valves, steam being generated in three Lancashire boilers, 30ft. by 7ft. diameter, at 100 revolutions, and a boiler pressure of 120lb., each engine developing 125 i.h.p. There were also three dynamos, shunt wound, driven by cotton ropes, and at 450 revolutions giving an output of 260 amperes at 250 volts. Mr. Dickinson stated that his overhead electric traction system extended for eight miles, and he explained the arrangements which had been made to overcome objections and difficulties. The members expressed themselves much pleased with the completeness of the arrangements and the excellence of the appliances, and came to the conclusion, from statistics put before them, that that was the most economical system of traction yet devised. The party then went on to Walsall by special car placed at their disposal by the company, and sat down to tea at the George Hotel, Mr. H. C. Peake, the president, being in the chair, and Mr. A. Smith taking the vice-chair. After the meal the president announced that the members were invited to send their students to a meeting of the Federated Institute of Mining Engineers at Newcastle-on-Tyne on August 13, and, upon his proposition, Mr. Cooksey was added to the representatives of this institute on the council of the Federated Institute, the other representatives being the president and Mr. W. J. Haywood. Mr. W. H. Whitehouse and Mr. G. Rogers as auditors, and Mr. Scott and Mr. J. Hughes as scrutineers, were reappointed. The President proposed a vote of thanks to Mr. Hall and Mr. Heming for their kindness at the steelworks, and to Mr. Dickinsom for like kindness at the generating station, remarking on the interesting information which had been supplied by these gentlemen. He added that no plant could be laid out more efficiently and economically than that for the working of the electric system, all the details having been most carefully considered. Mr. Traglass (Messrs. Tangye's works), in seconding the proposition, said that, as regarded the electric installation, it seemed to be complete in every respect, and as compared with the American systems, the members were pleased to see that for simplicity and general arrangement the palm was entirely with the South Staffordshire Company. What they had seen at the generating station made them proud, and they felt that the greatest credit was due to Mr. Dickinson, both as a mechanical and an electrical engineer, for the manner in which he had carried out the work.

The Parker Conduit System.—We have received from Mr. J. E. Parker, of the Commercial Cable Company, New York, a description of an underground electric conduit system which he has invented. It consists of an iron conduit about 18in. deep by 15in. wide, with a flange on the underside 3in. wide or thereabouts. This conduit is set on a level bottom in the centre of the track and spiked to the cross-ties, the top being flush with the roadway. An iron cross-frame is inserted in the conduit at regular intervals and bolted to the sides. About 3in. from the bottom there is a bar ½in. thick, with holes in the centre, to which the shank of the insulator is bolted. The insulator has a channel across the top, about ¾in. deep, for the reception of the metal conductor. The conductor is of metal, 2in. or more deep, and thick enough to fit exactly into the channel at the top of the insulator. It is bevelled at the upper side so as to prevent the accumulation of dirt on its upper edge. The various sections of the conductor are connected together. The conductor projects about 1in. over the top of the insulator. The trolley guard consists of two bars of metal projecting from the bottom of the car, wide enough to ride easily in the road slot, connected together by a flat frame of metal, having a slot in the centre, in which is placed a wheel, which also runs in the roadway slot. The trolley guard performs three important functions. It clears away all obstacles from the slot, protects the trolley shaft from injury against the sides of the slot, and the wheel (which is an expandable wheel) presses against the sides of the slot, forms the earth or return current of the electricity after passing through the motor. The wheel is made of hard steel, so that it may not easily wear away, and the continual passing of the cars keeps the sides of the slot in good condition for making a good electrical contact. The trolley shaft is made of vulcanite or ebonite or some other suitable non-conductor. Its peculiar formation at the end insulates it. A simple mechanical device enables the motorman to reverse the position of the trolley so that the car can run in an opposite direction. The trolley shaft passes through the slot in the trolley guard, and as the slot in the trolley guard is of less width than the roadway slot, the trolley cannot possibly touch the side of the roadway slot. The end of the trolley nearest the conductor is hollow or horn-shaped, which insulates the trolley wheel, and effectually prevents any escape of the current. A wire through the centre of the trolley carries the current to the motor. A flanged wheel at the end of the trolley rides on the top of the conductor, and the trolley is kept in its place by a strong spring pressing it on the conductor. It is claimed that in consequence of the direct contact of the trench all along its length, and of the whole of the metal-work with the earth, that not only

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is the contact for the return or earth current made with the greatest certainty, but any possible derangement of the conductor would be quite harmless both to person and property, because the conductor in that case would certainly touch some part of the metal-work of the conduit and make earth, thus preventing any effects of the derangement being felt even for 1in. from the spot where the contact takes place.

Metallic Sodium Produced by an Electrolytic Leak. — The Boston correspondent of the *Western Electrician* draws attention to a curious case in that town. It appears that the accidental sounding of an automatic fire-alarm in a Washington-street business house recently has brought to the attention of the Boston Board of Fire Underwriters a possible new source of danger from electric wires. According to the reports, for some time past a slight smoke has been seen issuing from the casement about the electric light wires in the basement of the Pray Building at the point where the wires enter from the street. When the insurance inspector arrived and the casement was removed it was found that a peculiar substance had accumulated about the wires, which, when moistened and struck with any hard substance, would give off flashes of fire. All around this point the woodwork was covered with a thick liquid, which had dried in places to a white substance resembling discoloured salt, and which was slippery to the touch and strongly corrosive. The wood itself was soft and badly discoloured. As this case was thought to be of considerable importance, it was placed in the hands of Messrs. Forbes and Glidden, electrical and chemical engineers, who immediately began an investigation. The deposit discovered about the wires proved upon analysis to be mainly metallic sodium. The substance is exceedingly combustible, and unites so readily with water that its presence in a damp cellar would be impossible under ordinary conditions. When it unites with water hydrogen gas is given off, and at the same time a considerable amount of heat is generated. Under certain conditions this heat would be sufficient to ignite the hydrogen gas. Hydrogen gas and air would form an explosive, and hence the greatest danger lies in the liability of an explosion if the gas should become ignited. The explanation of the appearance in a damp cellar of a substance so combustible and unstable in the presence of moisture as metallic sodium, is given as follows: The metallic sodium was undoubtedly the product of an electrolytic decomposition of impure sodium hydrate. This sodium hydrate came from the cement mortar used in laying the brick wall of the basement upon which the wires were supported. Some of the hydrate may possibly have worked its way through the wall from the cement used in the foundation of the paved street immediately adjacent. The electric current which caused the electrolytic action was due to a leak inside the casing from one of the mains. The leak was produced by the action of the sodium hydrate on the insulation covering the wires. This covering was what is known as weatherproof insulation, which consists of a cotton braiding covered with tar. Such a material is readily attacked by sodium hydrate, and its insulating properties destroyed. Moreover, the sodium hydrate itself furnishes a good path for the current when it has once penetrated the insulation. This case is especially interesting in connection with several of the explosions which have occurred in underground conduits, usually attributed to a leak in the gas-mains. In London it has recently been suggested that metallic sodium may possibly have something to do with these explosions. This, however, appears to be the first instance in which the appearance of metallic sodium has been proved and a complete explanation of an actual case given.

Prague Electrical Society.—At the last meeting of the Elektrotechnischer Verein in Prag, Prof. Dr. Puluj read a paper on "Magnetic Hysteresis and its Significance for the Construction of Dynamos and Transformers." In the armatures of continuous and alternating current machines, he said, and also in alternating-current transformers, the iron cores undergo a periodical remagnetisation, upon which a certain mechanical energy is expended and returned in heat. This magnetisation energy depends on the quality of the iron, and on the number of magnetic cycles or circuit processes, and amounts in a ton of soft wrought iron at 100 complete magnetic circuit processes per second to 17·6 h.p. In cast iron this expenditure of energy may be doubled, and in hard steel a still higher figure may be obtained. The author next discussed the methods by which the magnetisation energy of various classes of iron can be determined in a simple manner, and he explained how this energy is produced in consequence of the magnetic retardation or hysteresis of the iron, while the magnetism of the iron depends on the previous magnetic condition of the same. Dr. Puluj further demonstrated with the electrical lighting installation in the physical room of the society that with decreasing currents in the field magnets of the dynamo the excited magnetism, and, therefore, also the terminal pressure of the machine, are considerably greater than with increasing current-strength, which could be observed not only at the voltmeter, but likewise in the intensity of the light of the incandescent lamps. The author then communicated the results of many tests relative thereto, which had been made by himself and his scholars, and he remarked that hysteresis increases almost twofold the magnetisation energy in the iron wires experimented with if the latter are brought to a red heat in a charcoal fire or by means of alternating currents in the air. In conclusion, Dr. Puluj discussed the weakening of the magnetism which the iron bars suffer by division, as observed by Ewing, and showed how by using iron wire for armature cores, instead of sheet iron, the number of ampere windings necessary for the excitation of the field magnets must be substantially greater. Mr. Marschik then followed with a treatise on "The Effect of the Electric Current on the Carbonisation of Iron by Cementation." The author illustrated by diagrams the important part played by carbon in iron, and showed how the qualities of the metal altered with the carbon contents, thereby indicating the distinction between wrought iron, cast iron, and steel. He further showed that one kind of iron could easily be converted into another by introducing carbonising substances to iron poor in carbon; or, on the other hand, extracting carbon from a metal rich in that material by means of oxidising substances. Cementation is based on the first-named principle, which was carried out as early as the beginning of the previous century as follows: pure soft iron, of only 0·1 per cent. carbon, was embedded in charcoal and exposed to a clear red heat. In from 11 to 13 days the iron showed 1·2 per cent. of carbon, and after refining is transformed into an excellent steel. By using electricity the cementation process can be expedited in that, in addition to the heating, which makes the carbon molecules more easily movable, an electric current being conveyed to the iron through the charcoal facilitates the permeation of the carbon molecules into the interior of the iron. For this purpose a current of 55 amperes and seven volts is necessary, and, with a temperature of from 900deg. to 1,000deg. C., the process only lasts about three hours, the result being a steel layer of 10mm. (0·394in.), containing 1·2 per cent. of carbon.

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THE ANNUAL MEETING OF THE VERBAND DEUTSCHER ELEKTROTECHNIKER AT MUNICH.

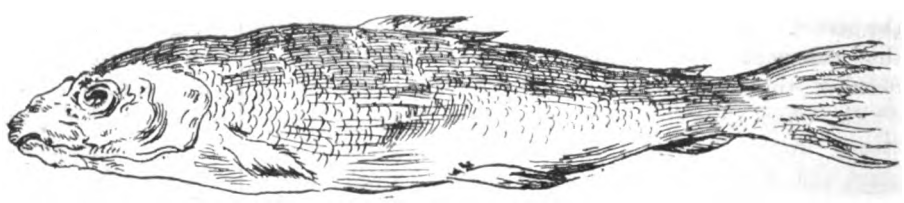
(BY OUR SPECIAL CORRESPONDENT.)

(Continued from page 74.)

JULY 6.

After viewing the distributing transformer stations at Thalkirchen, we took train again and returned to the suburban station to the south of Munich. There the electric power station for working the trams is situated, and the machinery in it was examined by the members. The buildings were not pretentious, but the plant installed was evidently well up to its work. Our party filled six cars arranged in three sets of two cars coupled together. The rear car in each set was an ordinary horse-car, having no motors on it. Then we started in series and raced back into Munich at an average speed of at least 12 miles per hour.

Primitive Grill.



The Renken.

The next visit was to the municipal electric lighting works. Mr. F. Uppenborn, the engineer of the station, was there to receive us and to explain the details of the various parts of the plant. The station is now in course of reconstruction and the water-power machinery is being greatly extended. The details of the engines, dynamos, and switchboards I hope to give fully later on from drawings which Mr. Oscar von Miller is sending to me. The type or general design of the station differs from any large English system I am aware of. The steam-engines supply power to a countershaft, from which the various dynamos are driven. A series of fast and loose pulleys are placed on this countershaft, acting as follow: Each dynamo is provided with a wide pulley, the face being equal to rather more than twice the belt width. Then on the countershaft two pulleys are provided, one fast and the other loose. When starting, the belt is on the loose pulley, and the two are forced together by levers till the friction is sufficient to start the loose pulley and the dynamo unloaded. Then when the normal speed is reached, the belt is moved over on to the fixed pulley by ordinary striking gear. To one end of this long countershaft a turbine is geared by the usual arrangement of mortice bevel wheel and pinion. At the other side provision is made for two more similar turbines, and the foundations are now ready to receive them. The works are situated on the south bank of the River Isar, in the midst of lovely gardens. The next item was a social *réunion* at the Isarluft Restaurant, but my appetite for imbibing information and liquid refreshment had departed, so I preferred a quiet evening with some friends at the hotel.

JULY 7.

This day was devoted to recreation rather than business, although those members who were sufficiently energetic paid a visit at 9 a.m. to the "central station of the central station which is not at the central station." I solved the above riddle and found that the electric lighting plant for supplying the central railway station was placed at a small depôt in the suburbs. After the works there had been inspected we went by special express train to Starnberg for the Starnberg See. The weather being propitious the scenery could be enjoyed to the full, although the distant Alps were at times obscured by mist. We took a "dampfschiff" to Schloss Berg, and then formed up in a straggling procession behind a local brass band, who played martial music to entice us along. Strolling along the path by the shores of the lake, we passed the memorial erected on the spot whence the mad King of Bavaria cast himself into the lake. There was no time allowed us to follow his example, although a swim in the clear waters would have been most refreshing. I was fortunate in securing Mr. T. W. W. Melhuish, of Vienna, as a companion during the day, and we had many notes to compare as to the old times when he superintended the lighting of the Inventions Exhibition at South Kensington for Messrs. Siemens Bros.

We took steamer again at the next landing-stage, and then had a most enjoyable sail round the "See," finally returning to Tutzing for luncheon. It seems that the lake is noted for a species of fish, called Renken, which is a great delicacy. The fish is of so delicate a constitution that it dies immediately it leaves the water when caught. The guide to the lake and district which was supplied us with our membership tickets was most useful on this occasion, and I wish the whole of the illustrations could be reproduced. After lunch, or rather between the courses, we had the usual speeches, which in this case had a personal tendency. Mr. Oscar von Miller, in proposing the health of Mr. Gisbert Kapp, referred in glowing terms to the work Mr. Kapp had done for the society during his first year of office, and congratulated him on being again in harness in the German Empire. Although I did not approve of the last sentiment, and wished we could have retained so able an engineer in England, I joined the troop of those anxious to clink glasses and "Prosit" with Mr. Kapp. After the tide swept back and we were again seated, other toasts were proposed; in fact, at one time two speakers wished to take the floor together, but the right of priority was amicably settled. After a pleasant homeward journey, first by steamer and then by rail, Munich was reached at about 8.30 p.m., and mutual farewells were exchanged. As I had to depart early the next day to visit various large engineering firms and central stations in Switzerland and Germany, I secured Mr. Kapp for a long chat lasting into the early hours of the morning. In conclusion of my Munich experiences I must add that the open welcome I received from all was most cordial, and never before have I made so many genial acquaintances in the short space of three days.

Renken Fishing.

Old Lake Dwellings.

My personal interviews with the various prominent

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electrical engineers of Germany and Switzerland will be published in due order, commencing with the Munich engineer—Mr. Oscar von Miller.

THE DUBIAU TUBULAR PUMP SYSTEM FOR BOILERS.

At the recent meeting of the Verband Deutscher Elektrotechniker, Mr. Friederich Ross read a paper on the subject of the system for boiler circulation invented by M. Paul Dubiau, manager of the Association des Propriétaires d'Appareils à Vapeur du Sud-Est de la France. Rapid circulation is one of the advantages aimed at in water-tube boilers, but often this is not obtained in practice. The author stated that a satisfactory and simple means of attaining proper circulation was the tubular pump of Dubiau. The application to an ordinary Cornish boiler is shown in Fig. 1. Round the furnace is placed a mantle which reaches almost to the bottom of the boiler and is closed at the top by a lid, a number of tubes being brought through this lid, and the lower end of the tubes being cut in the shape of a whistle. On heating this boiler a second steam-chamber is at once formed over the furnace. As soon as the pressure in this is greater than the pressure in the upper chamber, in addition to the pressure of the water column, steam bubbles enter the tube and press the water contained in them ahead into the upper steam-chamber. The lower water surface then appears at the upper corner of the oblique surface of the tubes, that under the pressure of the water column then remains constantly filled with water, and each jet of steam empties the contents into the space above. In this manner there is at hand a means of circulating any given quantity of water by proper selection of the section and the number of these tubes, which work just like a pump. Naturally, a large quantity of the water runs back to the bottom of the mantle, and it is thus possible to obtain such rapidity of circulation that in an hour the quantity of the water contained in the boiler is passed from 60 to 100 times over the heating surfaces. With such a great circulation, the formation of adhering steam bubbles is prevented. In consequence also of the rapid motion, there is no chance of deposit being burned on in the most dangerous part—that is, where there are high temperatures of plates.

Another application of the system is shown in Fig. 2, in which an underlying boiler is combined with a tubular boiler and here a collection of Dubiau tubes is placed in the foremost part of the boiler. The water lifted is returned to the lower drum through the two connections between the upper and lower boilers.

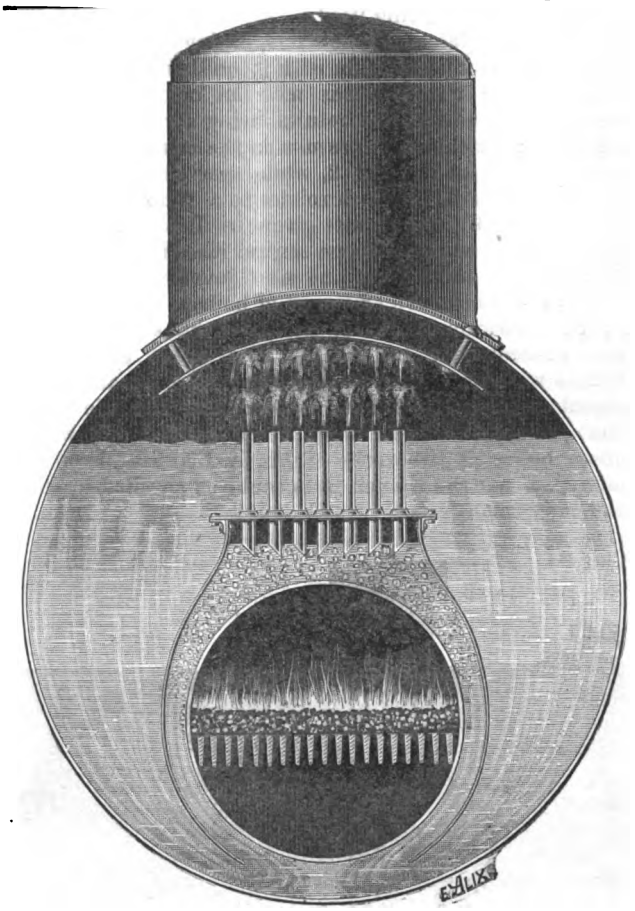

FIG. 1.

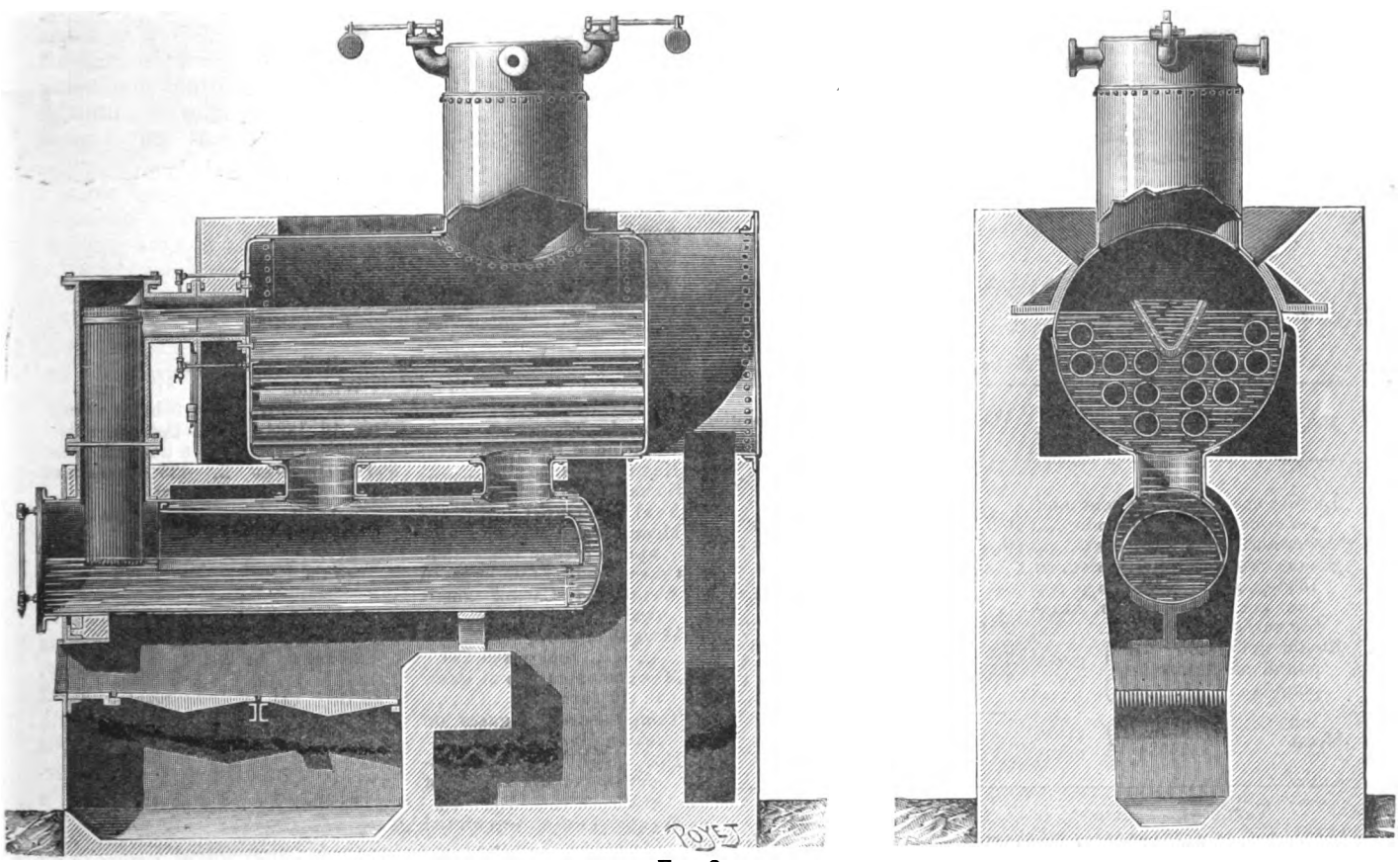

FIG. 2.

In Fig. 3 the Dubiau system is shown in connection with a tubular boiler, an application which can be readily understood. The water returns to the tubes nearest the furnace from the upper boiler by means of the ordinary return pipes.

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The author stated that tests had been made which showed remarkable results from the increased circulation, on the average capacity of the boiler was doubled without any additional fuel being used.

The Dubiau system is a new one, dating from 1893, and experiments have been made with it on boilers of various types. One of the first was with an ordinary boiler by Menard, of Marseilles, the results being given in Table I. In Table II. are shown the results in the case of a combined boiler, as illustrated in Fig. 2, while specially good results appear in Table III., which relates to a tubular boiler, as shown in Fig. 3. Other tests given in Table IV. relate to a tubular boiler at the Dieppe central electric light station.

The author claimed that the new invention allowed of raising the quantitative efficiency of boilers by from 50 to 15 per cent. without inconvenience, and that smaller boilers could consequently be utilised and space economised. Deposits were prevented, temperatures were equalised, and unequal expansion of plates avoided, and the life of the boiler prolonged. Tests were being carried out with a Dubiau boiler at the works of Mr. E. Leinhass, Freiberg, Saxony, so that the French tests could be checked by independent German tests.

Gas coke burned	1,060lb.	1 930lb.
Ashes	88lb.	165lb.
Mean temperature of the gases over the furnace	987deg. C.	1,060deg. C.
Mean temperature of the gases at foot of chimney	290deg. C.	266deg. C.
Water evaporated from 0deg. C. per net pound of coke	6·937	7·204

TABLE III.—Boiler by Aucoq and Darracy.

Heating surface	238 square feet.
Surface of grate	13 ,, ,,
Duration of tests	7 hours.
Mean pressure	71lb.
Corresponding temperature	158·4deg. C.
Weight of feed water	13,900lb.
Temperature of feed water	8deg. C.
Water evaporated from 0deg. C. to 158deg. C.	13,700lb.
Weight of coke burned	1,830lb.
Ashes	106lb.
Net weight of fuel	1,724lb.
Coke burned per hour	245lb.
,, ,, ,, square foot grate surface	17lb.
Water evaporated per hour	198lb
,, ,, ,, square foot of heating surface	89·8lb.
,, ,, ,, pound of fuel	7·59lb.
Deducting ashes	8·06lb.

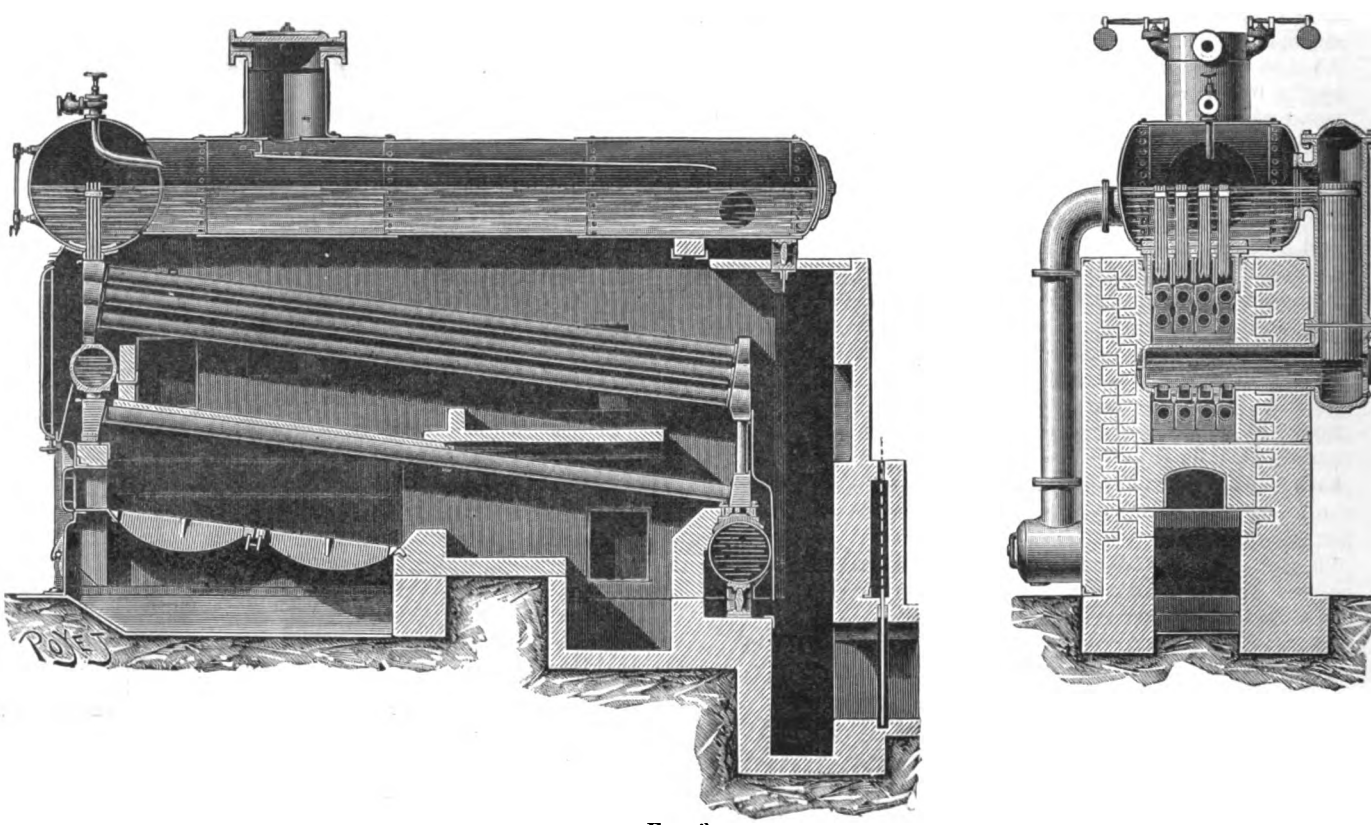

FIG. 3.

TABLE I.—Boiler by Menard, of Marseilles.

Heating surface, 218 square feet.		Without tubular pump.			With tubular pump.	
		I.	II.	III.	IV.	V.
Lignite consumed per hour and per square foot in pounds		16·8	26 6	30·3	15 7	27·5
Ashes and cinders per cent.		16	18	16	14	14
Steam generated from 0deg. to 158deg. at 71lb. pressure per hour per square foot of heating surface in pounds		2·15	3·06	3·28	3·47	5 85
Steam generated per pound of lignite in pounds	gross	3 8	3 37	3·28	4 2	4·06
	net	4·53	3 96	3 9	4·94	4·72
Mean	gross	3·49			4·13	
	net	4·13			4·83	

TABLE II.—Combined Boiler at Rue des Ardennes.

Heating surface, 228 square feet.	Without tubular pump	With tubular pump.
Date of test	Oct. 20, 1894	Oct. 10, 1894.
Duration of test	Eight hours	Eight hours.
Grate area	10·4 square feet	10·4 square feet.
Feed water	114 cubic feet	207 cubic feet.
Temperature of the water	13deg. C.	15deg. C.
Mean pressure	87·5lb.	85·5lb.

TABLE IV.—Tubular Boiler at Dieppe.

	Without tubular pump.		With tubular pump.
Date of trial	Dec. 16. 1894.	...	Dec. 15, 1894.
Duration of trial	8 hours 50 min.	...	8 hours 20 min.
Heating surface	800 square feet	...	433 square feet
Surface of grate	20 ,, ,,	...	21·6 ,, ,,
Feed water used	19.050lb.	...	19,200lb.
Mean steam pressure per square inch	117lb.	...	127·5lb.
Corresponding temperature	175·8	...	179
Weight of Cardiff small coal	2,960lb.	...	2,730lb.
Weight of ashes	201lb.	...	265lb.
,, ,, fuel consumed	2,759lb.	...	2,465lb.
Mean temperature of gases in the furnace	890deg. C.	...	865deg. C.
Temperature of gases on leaving boiler	368deg. C.	...	314deg. C.
Net weight of fuel consumed per square foot of grate	15·7lb.	...	13·6ft.
Weight of water evaporated per hour per square feet of heating surface	2 67lb.	...	5·32lb.
Water evaporated from water at 0deg. C. to 158deg. C. per pound of fuel used	6 86	..	7·78
Kilowatts produced by dynamos	220	...	241·1

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LIGHTNING ARRESTERS, AND WHY THEY SOMETIMES FAIL.*

BY ALEXANDER JAY WURTS.

When the first telegraph lines were installed it was noticed that the instruments frequently became damaged during thunderstorms. The wires were charged with static electricity, which, instead of following many turns of wire through the instrument to earth, would puncture the insulation between consecutive convolutions and thus short-circuit the coils. Besides this damage to the instruments, it was noticed that the static charge would sometimes spring from the line, or other metallic parts of the circuit, to neighbouring conducting objects, such as nails, iron pipes, and the like. It was also noticed that, when discharge occurred in this manner, the instruments were not damaged. In other words, these neighbouring objects formed by-paths for the discharge, and, in a measure, offered protection to the instruments. As a consequence of such observation, artificial by-paths were constructed, which consisted of two metal electrodes, separated by a small air space. One of these electrodes was connected to the line, the other to earth; and thus the first "lightning arrester" was constructed.

It was then supposed that, when a line was provided with a "lightning arrester," the instruments would be "protected against lightning." The result, however, proved this conclusion to be erroneous. The discharges would sometimes pass to earth over the spark-gap of the lightning arrester, but not infrequently would quite ignore the arrester and, as before, puncture the insulating material of the instruments. In other words, the discharge was selective. The failure of the lightning arrester was a vexation; but at that time, owing to the small amount of apparatus in use, the damage reckoned in dollars and cents did not call for any special study of the reasons for the selective character of disruptive discharges. In these days, however, the vast amount of capital invested in electrical apparatus of various kinds, and the consequent increase annual loss directly due to these disruptive discharges, have called for a thorough investigation of the subject, and the designing of more efficient means of protection.

It is a very significant fact that overhead wires, after being subjected to the influence of thunderstorms, do not show the damage to insulation which one would reasonably expect to find had the wires been actually struck by the lightning discharge. It is not uncommon, however, to hear of wires being "struck by lightning"; in fact, linemen will frequently volunteer to point out the exact spot where the lightning entered the wire. But, so far as I have been able to learn, overhead wires are not struck by lightning. The points usually selected by lightning discharges are trees, lightning-rods, church steeples, tall chimneys, and the like. There seems to be no reason why lightning should strike a horizontal wire, especially when it is insulated from the earth.

Overhead wires may become charged in three ways and combinations of these—viz., by static induction from the clouds, by dynamic induction from a lightning discharge, and by conduction from the surrounding charged atmosphere. The writer inclines to the theory of conduction.

During thunderstorms, and in many instances during fair weather, the atmosphere becomes charged with electricity at a constantly increasing potential as we recede from the earth. At the top of Washington Monument, Washington, D.C., a potential of 3,000 volts has been measured during thunderstorms, and at the top of the Eiffel Tower a potential of 10,000 volts has been measured. Now, it is well known that lightning is oscillatory. The first oscillation, or discharge, makes a crack or hole through the atmosphere, and through this the succeeding oscillations take place. About 10 to 12 oscillations can be observed, and the time interval is reckoned at about ·00001 of a second. The lightning, therefore, being oscillatory and the atmosphere charged, if an overhead wire be charged by conduction from the atmosphere—that is, become electrically a portion of it—then, with every lightning discharge it would seem as though the potential of the atmosphere would sympathise with the oscillatory character of the lightning, and that the charge in the atmosphere would also oscillate and produce oscillations in overhead wires, and, in fact, in all metallic conductors, such as wire fences, rails, etc. The fact that wires become heavily charged during fair weather offers further evidence that they are charged by conduction from the surrounding charged atmosphere. In some instances lightning arresters have been known during perfectly fair weather to discharge overhead wires at the rate of 140 times a minute.

In any case, whatever the method of charging may be, the discharges from overhead wires seem to be oscillatory, and during thunderstorms they are in most cases simultaneous with lightning flashes.

If we raise one end of a trough of water and then quickly lower it, the water will quietly surge back and forth. If, when the water is returning, we again raise the same end of the trough, a wave will be started forward, which, meeting the returning wave, will combine or collide with it, causing a piling up of the water at that point. Further complications may be introduced by repeatedly, and at proper intervals, raising and lowering one end of the trough. If the crests of these waves be carefully examined, it will be noticed that they differ in height and are constantly shifting their positions.

During thunderstorms the static electricity in overhead conductors surges back and forth very much as the water in a trough, and the indications are that electric waves are set up which combine and interfere with each other in such a manner as to produce frequent and unequally distributed points of high and low pressure. The ends of wires are points of reflection, and at these points the pressure is always great. Whatever may be the true explanation of the apparent idiosyncrasies of disruptive discharges, it is, after all, with facts that we have to deal.

Referring to Fig. 1, let A A represent the terminals of a static induction machine, L a battery of six one-half gallon Leyden jars, B a spark-gap of $\frac{1}{32}$in., and C_1, C_2, etc., variable spark-gaps, and let the connections be as indicated. With discharges at B, discharges will also occur at one or more of the gaps, C_1, C_2, etc. When C_1, C_2, C_3 are equal, the discharges occur across these gaps indiscriminately. When discharge occurs over small gaps in the neighbourhood of C_1 or C_2, thread-like discharges are always noticed at Cn, and even when Cn is increased to $\frac{17}{32}$in. the thread-like discharge is still noticeable with every discharge at C_1 or C_2. If a large number of spark-gaps, varying among each other as much as 100 per cent., be distributed as C_1, C_2, C_3, etc., discharges will still occur indiscriminately, sometimes across a large gap, sometimes a small one, sometimes across three or four consecutive or widely distributed gaps. When C_1 is equal to $\frac{5}{32}$in., C_2 equal to $\frac{17}{32}$in., and placed two, three, or more feet away from C_1, and if C_3, C_4, etc., be omitted, then a discharge will occur at C_2 once in about 500 times without any discharge at C_1. These experiments demonstrate the selective character of the discharge. If, however, C_2 be increased to $\frac{18}{32}$in., the discharges will cease altogether at that point, and this last experiment indicates the limit of range over which selection may take place under the conditions given. But it is perfectly evident that with a large number of gaps, the probability of discharge across any one gap is very much less than if only two gaps were present. In other words, if C_1 represents a piece of apparatus which we desire to protect, the protection will be greater as we increase the number of spark-gaps, C_2, C_3, etc., but in no case can there be certainty of protection unless the gap, C_1, be relatively so large—or, more broadly speaking, unless the path, C_1, offer such a high resistance to the passage of disruptive discharges—as to place it beyond the limit of selection. The apparatus which we have used in the above experiments is different from that employed by Nature; the results, however, so far as my observations go, are identical, and the lesson to be learned is simple; it is this: the probability of damage to electrical apparatus connected to overhead wires is lessened as we increase the number of opportunities for discharge from the line.

In summing up thus far, we notice briefly that the line becomes charged, surgings are set up, there are points of reflection which are always points of great electrical strain,

* Lecture delivered before the Franklin Institute.

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there are points along the line of varying intensity or tendency to discharge, these points are constantly shifting their positions, and spark-gap lightning arresters are used, to conduct disruptive discharges to earth.

The lightning arrester of to-day, as a protective device, differs from the lightning arrester of the early telegraph in detail only. A simple spark-gap, one terminal of which is connected to the line and the other to earth, is essentially the lightning arrester now in use. But, with the modern high-potential circuits, it is found that the dynamo current follows the static discharge across the spark-gap of the arrester, causing thereby a short-circuit or dangerous ground on the line. In order to avoid this difficulty, arc-rupturing devices are attached to the lightning arrester, which have for their function the immediate interruption of the dynamo current, without interfering with the further operation of the lightning arrester as a discharging device. "Automatic lightning arresters," as they are called, differ among one another in the various means adopted for rupturing the dynamo arc. But the arc-rupturing attachment has nothing whatever to do with the apparatus as a lightning arrester, so that although automatic lightning arresters vary in outward appearance, and are in general more cumbersome and expensive than the original simple spark-gap arrester, yet, as lightning arresters, they are nothing more than spark-gaps. Various lightning-arrester attachments have been designed for the automatic rupture of dynamo arcs, but owing to the very high potentials which are so often used, they are found to be not only undesirable, but inefficient, the lightning arresters being frequently destroyed by the vicious dynamo arc.

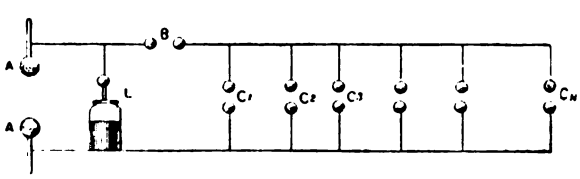

FIG 1.—Experiment with Line Arresters, Illustrating Selective Character of Discharge.

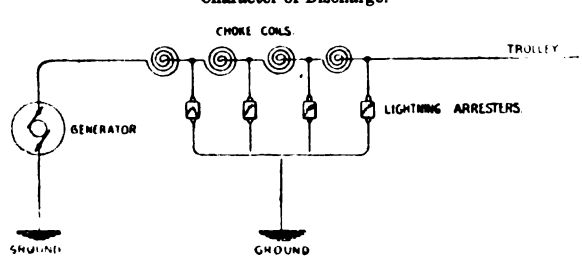

FIG. 2.—Four Choke Coils, with Lightning Arresters Intervening.

In practice, however, complaints are not so much that lightning arresters are destroyed as that they "fail to protect." It is not unusual to see several different kinds of lightning arresters in a single station, which have evidently been installed with the idea of determining which one of them would prove the most efficient. But such experiments have met with disappointment, for the reason that sometimes one lightning arrester, and sometimes another, would receive the discharge, and the selective character of disruptive discharges was not understood. The failure of lightning arresters is not due to the particular kind of lightning arrester, or to the patent under which it is manufactured; it is due largely to the peculiar conditions with which it has to contend—namely, that the discharge is selective, and that, in order to protect apparatus, means must be taken to control these selections, or, at least, to provide so many paths to earth that the probable selection will be one of the many paths provided. In other words, lightning arresters do not "protect"; they simply offer opportunities for discharge. These opportunities may or may not be embraced, according to circumstances. But the failure of lightning arresters is not altogether due to the peculiar conditions already referred to. Poor ground connection, inductive resistance in the ground circuit, defective insulation in the apparatus to be protected, and a general misunderstanding of the subject, are not infrequently the cause of serious losses which might otherwise have been avoided.

We have noticed that lightning arresters do not "protect," that they simply offer opportunities for discharge. We have also noticed that discharges do not pass readily through coils of wire: coils therefore protect. Properly-constructed choke coils, connected in the circuit, offer a high resistance to the passage of disruptive discharges, and when used in connection with lightning arresters, the combination offers a very reliable means of protecting well-insulated apparatus against lightning. Laboratory experiments, together with tests made under actual working conditions, indicate the advisability of using four choke coils in series, in each wire, with four lightning arresters intervening, as shown in Fig. 2. This arrangement is more particularly suitable for the protection of station apparatus. Coils can, however, be used to advantage on the line for the protection of the more expensive translating devices.

The general construction of a choke coil is a matter of considerable importance. A flat spiral possesses some advantages over the helix, but for practical purposes these hardly compensate for the lower cost of the latter, which for best results should be wound over a wooden or other non-conducting core. Metal cores and cases should be avoided, because the induced currents in these parts would lower the choking effect of the coils. The number of turns which can be used to advantage is limited. It is found by experiment that with given conditions the choking effect increases with the number of turns up to a well-defined critical point, after which additional turns fail to have any appreciable effect. It is probable that these critical points vary with the amount of electricity discharged—that is, for heavy discharges the critical point for maximum choking effect would embrace a larger number of turns than would smaller discharges, and the choking effect for a given number of turns within the critical point would also be greater for heavy than for small discharges. For practical purposes, the writer recommends from 40ft. to 50ft. of wire wound either into a flat spiral having an internal diameter of 3in., or into a 3in. helix with a single layer.

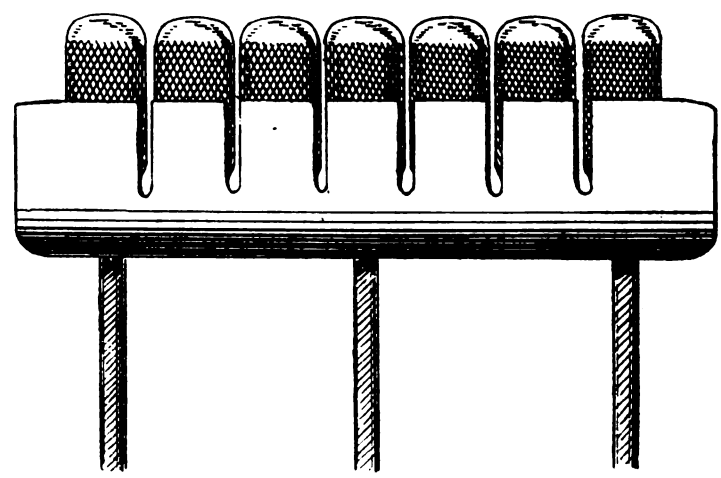

FIG. 3.—Double-Pole Non-Arcing Metal Line Arrester.

Summing up once more, we note that wires become charged, that lightning arresters offer opportunities for discharge, and that coils protect. Bearing in mind these three points, let us note that, with the extensive systems of electric light and power distribution now in use, it would be quite impracticable to instal the above-described system of choke coils and lightning arresters for the protection of each separate piece of apparatus. The first cost of such an installation would be prohibitory. It is evident, therefore, that the protection of line apparatus with choke coils being excluded there remains but one alternative—namely, that of providing such a large number of opportunities for discharge, distributed over the entire system, that the selection of the discharge will be one or more of the paths provided for it. In other words, line arresters connected at frequent intervals offer the only practical method of protecting widely distributed apparatus. But, in order that such an installation may prove satisfactory from a commercial as well as an operative standpoint, the arresters must be cheap, simple, free from moving parts,

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and perfectly reliable without the necessity of regular inspection.

Realising that these points were not covered by any one of the many automatic lightning arresters which had already been devised, I undertook to simplify the problem, and in my early experiments proposed to equip the lines of electric systems with a multiplicity of spark-gaps, and at the station to provide an automatic circuit opening-and-closing device, which upon the formation of a short-circuit across one or more of the spark-gaps on the line would instantly open and then immediately close. While experimenting with this system, I discovered that if the electrodes of a lightning arrester were made of zinc, the short-circuiting arc, which had heretofore threatened the life of the lightning arrester, absolutely failed to be maintained. In other words, zinc proved to be what is now commonly known as one of the "non-arcing" metals. Subsequent investigation disclosed the fact that there were four other metals which exhibited similar characteristics—namely, bismuth, antimony, cadmium, and mercury.*

The discovery of the non-arcing metals at once solved the problem of a lightning arrester adapted to the requirements of alternating-current circuits, and which would meet the conditions already enumerated.

The non-arcing metal lightning arrester, which is illustrated in Fig. 3, consists, as will be seen, of seven non-arcing metal cylinders, insulated from each other, each 1½in. long and ⅝in. in diameter. When installed, the two outer cylinders are connected to either leg of an alternating-current circuit and the central cylinder to earth,

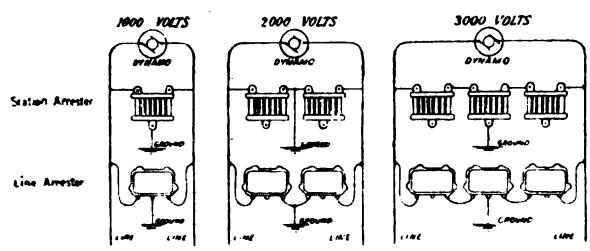

FIG. 4.—Diagrams for Lightning Arrester Connections on Circuits of Different Potentials.

thus forming a double-pole lightning arrester. In practice these are manufactured in units for 1,000 volts, so that for 2,000 volts two are connected in series, for 3,000 volts three are connected in series. The diagrams in Fig. 4 indicate the connections for each potential. There are many thousands of these lightning arresters in actual service, and the experience of three years has fully demonstrated that they are perfectly reliable without the necessity of regular inspection. The simplicity of the device is at once apparent, and the cost to the user is a mere fraction of what was formerly demanded for the best types of automatic lightning arresters. It will thus be seen that, at least for alternating-current circuits, the requirements of a commercially serviceable line lightning arrester have been fully met.

The success of the non-arcing metal lightning arrester was such that I was induced to make further investigations as to the possibility of constructing an equally simple and efficient device for use on direct-current circuits. In view of the many experiments which I had made with almost every kind and combination of the ordinary metals, I had become convinced that I should not be able to construct a non-arcing lightning arrester for direct-current circuits which would derive its non-arcing property from the nature of the material of the electrodes, as is the case with the non-arcing metal lightning arrester. Accordingly I directed my attention to the possible suppression of the dynamo arc by virtue of the construction or relation of the parts.

I had already observed the remarkable ease with which disruptive discharges strike over insulating surfaces, as compared to the difficulty with which they ordinarily pierce the air. For example, disruptive discharges will strike over a glass surface, between two electrodes placed 8in. apart, rather than pierce the air between electrodes placed 1in. apart and shunting the electrodes in contact with the glass. If ground glass be used and a pencil mark be drawn between the widely separated electrodes, the ratio between the distances over the glass and through the air is increased. While endeavouring to avail myself of this principle of "surface discharge," as I have called it, it occurred to me that a dynamo arc, in order to exist, must be fed by the vapours of its electrodes, and that if such vapours could be suppressed, or if their formation could be avoided, an arc could not possibly exist. Placing these two ideas together—namely, "surface discharge" and "suppression of the vapours"—I at once had the fundamental principles necessary for the construction of what has since proved to be a most simple and efficient non-arcing lightning arrester for direct-current circuits.

In the first experiments which led to a practical adaptation of these ideas to the construction of a lightning arrester, I placed two aluminium-foil terminals between the surfaces of two small blocks of marble, the surfaces of which had been carefully ground, and on one of which I had drawn a pencil mark which should bridge the distance between the foil electrodes. At first these electrodes were placed about 2in. apart, the two blocks of marble were firmly bound together with twine, the terminals were connected to the terminals of a 500-volt direct-current generator, and disruptive discharges were then caused to pass from one foil terminal to the other, between the marble blocks and over the pencil mark. It will at once be seen that the function of one of these marble blocks was to furnish a surface discharge plane, that the pencil mark was to further facilitate the passage of the disruptive discharge, and that the function of the second block, which was firmly bound to the first, was to suppress the formation of vapours, which would otherwise serve to establish a short-circuit under the conditions of the test. No arc being formed, the terminal foils were brought successively nearer to each other, until, finally, when the discharge plane had been shortened to ¼in., a short circuit was established.

Without entering into the details of subsequent experiments leading to the practical construction of a commercial lightning arrester, it may briefly be stated that in the final form wood, having been found more durable, has been substituted for marble, and, in place of the pencil marks, shallow grooves are burned longitudinally between the terminal electrodes, which are placed ⅝in. apart. While submitting this form of lightning arrester to long-continued tests with disruptive discharges, it was found that there was a gradual wearing away of the wood fibre, which eventually ended in the formation of a cavity in which vapours formed in sufficient quantity to establish a dynamo short-circuit. The wearing away of the fibre seemed to be due to the fact that no special vent, or opportunity for displacement, was provided for the disruptive discharge. This evil was quickly cured by slotting the upper block at right angles to the charred grooves in such a manner as to open up the grooves or discharge plane to the air, without, however, uncovering the electrodes.

It will now be proper to notice the distinctive features of the two non-arcing lightning arresters which have been described. The non-arcing metal lightning arrester is non-arcing by virtue of the material of its electrodes, and though "non-arcing," nevertheless allows of the dynamo short-circuit. This is, however, so quickly interrupted, probably by virtue of non-conducting vapours which form between the electrodes during the first rush of current, that no appreciable burning or damage to the electrodes can be noticed, and the melting of fuses and consequent interruption to the service are entirely avoided. On the other hand, the non-arcing lightning arrester for direct-current circuits is "non-arcing" by virtue of its construction, and more than this, is, strictly speaking, a discriminating lightning arrester, in that it allows disruptive discharges to pass freely without allowing any dynamo current at all to follow. This last feature is one which has enabled me to make some interesting investigations regarding the relative volume of discharges from overhead wires during thunderstorms.

* A full description of the researches and experiments which led to the discovery of the non-arcing metals is given in the *Transactions* of the American Institute of Electrical Engineers for March 15, 1892.

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While carrying on a series of experiments in Colorado during the summer of 1893 I connected in series with a number of these discriminating lightning arresters small spark-gaps, into which I inserted pieces of tissue paper, which were intended to act as tell-tales, and which, by the holes punctured by the discharges, gave me some record of what was going on. Some of these tell-tale papers are shown in Fig. 5. It will thus be seen that, although the discharges which caused these holes were larger than is ordinarily obtained with a battery of Leyden jars, they are not to be compared with the holes which one would expect from the lightning flashes which are so often said to "strike the lines." The fact that these tell-tale papers were not burned is sufficient evidence that the dynamo current did not follow the discharge.

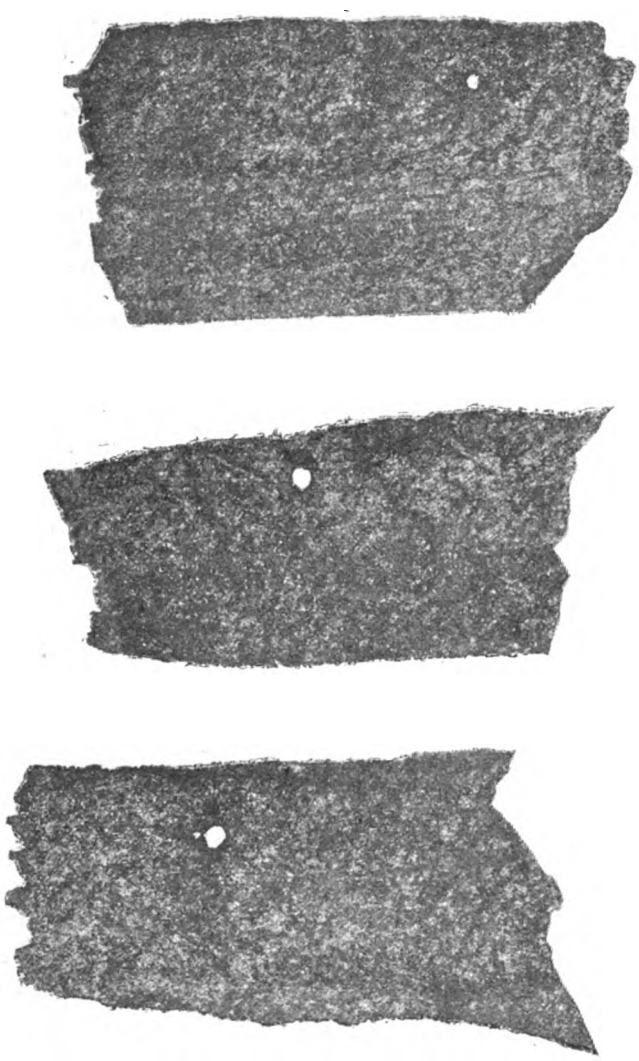

FIG. 5.—Tell-tale Papers.

There is, however, another side to this matter of protection against lightning—one which has been little discussed, and which is almost invariably overlooked by those to whom interruptions due to lightning are a matter of vital importance. I refer to the insulation of the apparatus to be protected. When a lightning arrester "fails to protect" it is condemned, the general opinion being that the failure is due to some inherent fault in the lightning arrester. But we have already learned that a lightning arrester is nothing more than a spark-gap. It would be difficult, then, to conceive of anything fundamentally wrong with a lightning arrester, so far as offering an opportunity for discharge is concerned. We have also learned that disruptive discharges do not always embrace the opportunity for discharge which is offered by a spark-gap lightning arrester. This circumstance, a very frequently occurring one, explains why lightning arresters sometimes fail. Another and all too frequent cause is defective or improperly applied insulating material. In a certain sense a lightning arrester is a safety valve. One would not expect to protect a defective or weak boiler with a safety valve set to blow at or near the bursting strain of the boiler; no more should we expect a spark-gap lightning arrester to protect weak or defective insulation.

Defective insulation results either from weak insulating material, or a faulty application of the insulating material. Generally good insulating material is used. Faulty application may result in two ways: (*a*) through improper design; (*b*) through carelessness or ignorance. Examples under (*a*) are: (1) exposed surfaces offering opportunities for "surface discharge," and this is not an infrequent occurrence in connection with insulating materials which would otherwise stand very high voltages; and (2) insufficient allowance for a proper margin of safety. The effects of rough handling, heat and cold, damp and dry atmospheres, dirt and grit (this latter having a particular attraction for electrical apparatus, etc.), demand a margin of safety which is not always appreciated even by the designer. Under (*b*) might be mentioned a long list of details, such as bruises, cracks, pinholes, cuts, open joints, bits of metal embedded in the insulation, sharp corners, etc., which will tend to lower the insulation strength 50, 75, or even 100 per cent. And at this point it should be observed that the weakest point in the insulation of a given piece of apparatus (it may be a pinhole or minute crack invisible to the naked eye) is a measure of its insulation strength.

Repair work in shops of local electric light and power companies is liable to be more or less defective, and but few such companies are provided with testing sets. Repaired armatures and converters are placed in service, and might stand indefinitely the normal E.M.F. of the circuit to which they are connected, but field discharges, lightning, rise of potential, and proximity to other circuits carrying high potentials demand a margin of safety which cannot be assured unless the insulation be actually tested with an E.M.F. from four to six times the normal.

But, even though the insulation of apparatus be perfect and have its proper margin of safety when installed, deterioration may nevertheless occur from various causes, principal among which would be moisture and overheating. In general, it may be stated that if we undertake by means of spark-gaps to provide absolute protection against static disruptive discharges, the insulation strength must bear such a relation to the spark-gaps as to place it beyond the limit of selection. Ordinarily, however, absolute conditions do not occur in practice; we can but approximate to them, and then philosophically accept a reasonable percentage of failures as inevitable.

The failure of lightning arresters is too often due to careless installation. It may be instructive to note several examples:

(1) One plant is reported as having, for better protection, connected two arresters in series. This was probably done with the idea that if a little was good more would be better.

(2) A large bank of station arresters was grounded to an iron bolt about 2ft. long, driven into dry sand.

(3) Line arresters were grounded by pushing the ground wires into the earth.

(4) Line arresters were grounded on iron poles, which were themselves set in Portland cement.

(5) An annual inspection of automatic lightning arresters developed the fact that the arresters were nearly all burned out—in other words, that the line was left unprotected.

(6) The ground plate of a bank of arresters was thrown into a neighbouring stream, which subsequently changed its course, leaving the ground plate high and dry.

(7) The ground plate of a bank of station arresters was laid on the rock bottom of a neighbouring stream.

(8) In a large number of cases a portion of the ground wire is wound into a fancy coil (choke coil). And the list might be indefinitely extended, each such case forming a source of complaint that the arresters "fail to protect"; but when these curious mistakes are located and properly remedied the complaints cease.

Summary.—Overhead wires become charged. They are discharged through lightning arresters, which are spark-gaps. Shifting points of high and low pressure are formed

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along the line, so that the discharge does not necessarily occur over the shortest or easiest path—that is, the discharge is selective. Lightning arresters offer opportunities for discharge. Coils protect. A liberal distribution of line arresters offers the only practical means of protecting widely distributed apparatus.

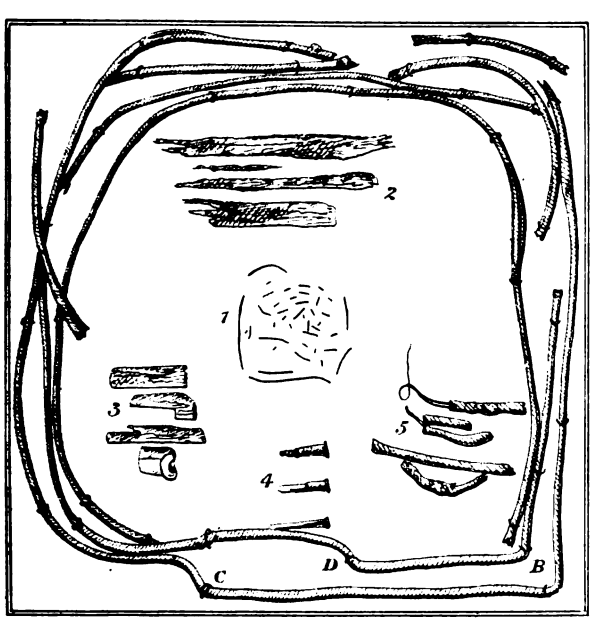
Lightning arresters fail to "protect"; first, because of the shifting high and low pressure points, or, in other words, for lack of a sufficient number of line arresters; second, because insulation is defective; and, third, because lightning arresters are not properly installed.

A SINGULAR EFFECT OF LIGHTNING STROKE IN CHICAGO.*

BY W. M. STING.

On September 7, lightning struck the factory building of the Illinois Industrial Home for the Blind. But slight damage was done to the building, though some of the effects on the electric light wires were most singular.

The writer is indebted for the facts here noted to Mr. Thomas Appleton, civil engineer, of Chicago, who was the superintendent of construction for the building. The Industrial Home is located on Douglas Boulevard, Chicago, the factory building being near the C. B. and Q. tracks. In his report to the Board of Trustees, Mr. Appleton states: "During the storm of last Friday night the chimney of



Effect of Lightning Stroke on Interior Wiring.

the factory was struck by lightning, and about 6ft. of the south side of the chimney knocked down. The lightning also entered the room in the south-east corner of the upper floor, and destroyed some 50ft. of insulated wire, one drop cord and pendant, and the switchbox. A large sliver was knocked off from the lower side of one of the roof beams, and it was a wonder the roof was not set on fire. Probably the whitewashing of the beam hindered the kindling of a fire at this point."

The roof beams were anchored by iron plates spiked on to the sides of the beams and extending through the wall, with large cast-iron washers outside the brick. The electric light wiring was open, cleated work, and was carried around the beams near the anchor plates. The lightning apparently struck an anchor plate and passed from this to the wiring. It knocked a near-by switchbox to pieces, breaking the porcelain fixtures and burning the screws. The upper screw of group 4 in the illustration shows the iron near the end melted out, leaving only the thread, like a spiral spring. Group 3 is a splintered oak cleat, while group 2 shows some slivers knocked off the beam.

The effect of the lightning on the wires is the singular part of the case. The outside diameter of the wire was $\frac{3}{16}$in., the conductor being No. 14 A.W.G. Around the conductor was a soft layer of white rubber, over this a layer of black rubber, which was covered with the usual protecting layer of braid. The insulation was heavily coated with compound and finishing varnish. About 10ft. of the insulation is shown in the illustration, for it is only a tube, the wire for the most part having disappeared, except between the letters B, C, and D. Group 5 shows damaged pieces with the conductor present, though badly burned. The outside of the insulation in many places plainly shows the effect of heat; the varnish has disappeared and most of the compound melted out. At irregular intervals there are openings or ruptures. A few feet was split open and the rubber core found intact, and only in a few places did it show traces of burning. There were scarcely any traces of copper markings that would indicate the wire had been vaporised. After the accident the conductor was found scattered about the floor. For the most part, the pieces were from $\frac{1}{4}$in. to $\frac{3}{4}$in. in length and quite regular. Group 1 shows a number of these pieces. The wire seems to have been literally shot out from the insulation as from a gun. The uniformity of length of these pieces is significant. When a long piece of fuse wire is blown it invariably breaks into a number of pieces of quite uniform length. The two cases seem quite similar and indicate in a manner some form of rhythmic action. The faces of the ends in both cases are square and crystalline. This would suggest that the copper conductor was fused internally, but cooled rapidly when exposed to the air. Only a few of the pieces are pitted and badly burned. An occasional piece of wire was found in the inner tube, but they were of uniform length with those that had been ejected.

* From the *Electrical Engineer* (New York).

FRANKFORT CENTRAL ELECTRIC SUPPLY STATION.

The following is a list of charges for current made by the Frankfort-on-Maine Central Electric Supply Station:

Current for electric lighting purposes, 80 pfennige, or 9½d., per kilowatt-hour, with the following discounts:

5	per cent.	for a consumption of	over	300	hours.	
10	,,	,,	,,	,,	500	,,
15	,,	,,	,,	,,	750	,,
20	,,	,,	,,	,,	1,000	,,
25	,,	,,	,,	,,	1,500	,,
30	,,	,,	,,	,,	2,000	,,

The number of hours of consumption being taken by a division of the power required by the lamps installed into the number of killowatt-hours of consumption.

Current for electric motors (except those used for driving dynamos or serving batteries for lighting purposes) for heating and for electro-chemistry: 20 pfennige, or 2⅖d., per kilowatt-hour, with a discount on the total consumption.

5	per cent.	for a period of	running	of	over	750 hours.
10	,,	,,	,,	,,	1,000	,,
15	,,	,,	,,	,,	1,500	,,
20	,,	,,	,,	,,	2,000	,,
25	,,	,,	,,	,,	2,500	,,

The number of running hours being taken by the division of the number of kilowatts required for the normal supply of the motors by the number of kilowatts used in the year by the consumers.

The meters required are hired to the consumers at the following rates, and remain the property of the electric supply station. The cost of maintenance and repairs is borne by the station, provided the damage has not been caused by the hirer. The yearly rental is—

For meters up to	0·5	kilowatts	.....	15s.
,, ,,	1·0	,,	.....	20s.
,, ,,	2·0	,,	.....	30s.
,, ,,	4·0	,,	.....	40s.
,, ,,	10·0	,,	.....	50s.
,, ,,	20·0	,,	and over	60s.

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CENTRAL-STATION FINANCE.

Anyone reading the technical and non-technical Press systematically with the idea of ascertaining the true financial positions of the various electric light stations in this country, will be considerably mystified unless he has unlimited powers of supplying lacking information. He will cull from some after-dinner speech of a prominent member of the profession that a total cost for generation of three-pence per unit is rarely exceeded in well-designed electric light stations of the present day. Next, he will find that at Frankfort the charge per unit is only to be three-farthings for certain purposes. Then, carrying him still further in the rapid descent of prices, he will learn that the Niagara Power Company only charge one-eighth of a penny per unit. We can imagine a gentleman, after the course of reading referred to, saying, "Well, electricity is in its infancy in England, and the selling price here will fall rapidly." The next day, perhaps, he finds that some company which should be able to generate current cheaply is losing money when selling at eightpence per unit. His natural assumption is that the engineer and all concerned with the said supply are at fault. Roughly, we would divide all electric supply concerns into two classes, the first of which we are thankful to be mostly concerned with in England—*i.e.*, those electric lighting works started with the object of supplying light and power, and looking to the revenue derived from such sources to pay a reasonable interest on the money invested. The second class includes all companies started for either promotion-money or for ulterior purposes, such as land speculation. This latter class we do not consider in the following remarks, as their prices are not regulated by the considerations of supply and demand. In dealing with the first division, we consider that a too close attention to the average cost of production is apt to lead to a short-sighted, hampering policy. Mr. G. J. Melms, the engineer of the Frankfort station, in a letter we publish in this issue, touches on the question from the commercial aspect, and we endorse his method of reasoning. The average cost per unit does not in any way represent the cost per unit of generation at an average period. During the heavy lighting periods in the winter, ranging, say, from 4 to 10 p.m., the cost of generation is exceedingly small when the large outputs are considered. At other periods of the day, and almost all day in the summer, the actual cost of production per unit exceeds the price obtained from the consumer. We should proceed to reorganise the prime-cost sheets as follows: Assuming the primary object of the station is lighting, and that the great bulk of the plant is only running during the hours of maximum lighting, the capital charges and a large percentage of the managerial charges should fall on the lighting period. The income from the units sold for lighting purposes can, at least in England, always bear these charges. Then we have left the unprofitable periods, amounting to at least three-quarters of the total hours in the year. During this time the engines, boilers, and general machinery have to be

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kept running to supply next to no load, and the wages' bill and depreciation are almost as heavy as when all the plant is at work. The coal consumed per unit supplied is enormously higher than any published figures, and the engines are apt to give more trouble when running light. Then our Frankfort correspondent steps in and says, Supply at cost price of labour and coal during this period if you can get a large consumer. The low figure mentioned in connection with his station was for a 120-h.p. motor to be run almost continuously, which mean an income of about one thousand eight hundred pounds per annum. The consumer thus gets his power at the not unreasonable figure of fifteen pounds per horse-power. The station engineer will in this way practically provide for the light-load coal bill. It looks somewhat like making money by selling large quantities of electricity at a loss if the average prime cost is considered, but it is in our opinion a sound business policy. The other smaller motors, of course, would not get the supply at such advantageous terms. Another vexed point with station engineers is that of street-lighting. It seems to be an acknowledged custom amongst technical advisers to corporations to insist that arc lamps shall be supplied at considerably less than cost price. We suppose the City of London Company set the example by openly accepting street-lighting at non-paying prices. Here there was an object, and they succeeded in getting a concession entitling them to supply the rich City consumers at eightpence per unit. The profit on the private consumers has already swamped the public lighting loss, but in provincial towns this is often not the case. When the electricity works are owned by the corporation, we fail to see why the electric lighting committee should not charge the full cost of production, plus interest on capital, to the street-lighting officials. The present policy simply falsifies the balance-sheet of the electrical engineer in charge, and circulates the idea that the electric department is losing money. This is done in order that the street-lighting bill may be kept low. In conclusion, we would again advise those engineers and committees who wish to make their electric light stations more successful, that they should supply power to consumers requiring the same continuously at a price at which it will supersede other prime movers of moderate powers.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

COST OF POWER.

SIR,—In your editorial of July 5, commenting upon the cost of power at Niagara Falls, you make the statement that the capital charges alone would appear to prohibit a profit when power is supplied at ⅛d. per kilowatt-hour. Your assumptions are unquestionably right if the Niagara Falls Power Company supplies all of its power at this rate, a rate which would soon place any ordinary company in the hands of a receiver. However, even with as low a price as ⅛d. per kilowatt-hour, the Niagara Falls Power Company may reap advantage provided the consumer is not permitted to use power at the time when the maximum lighting load is upon the central station.

The cost of producing a kilowatt-hour in a station that is in operation 24 hours per day should, in my opinion, be divided into two parts: (1) interest on cost of plant, etc., depreciation, salaries, and that portion of the labour, water, and coal used during the time of maximum load for lighting purposes, or say, in round figures, four hours per day; (2) the cost of coal, water, and labour used during the balance of the day, or 20 hours. In this way, the cost per kilowatt-hour under the conditions just mentioned depends upon the time of the day when it is produced; in Frankfort the cost per kilowatt-hour in case 1 is about three to four times as great as in case 2, due to the establishment charges being debited to the lighting period only.

For lighting purposes, the Frankfort station charges at the rate of ·80M. (9·6d.) per kilowatt-hour, with discounts ranging from 5 per cent. to 30 per cent., according to the lamp-hours used during the year. The rate for power is ·20M. (2·4d.) per kilowatt-hour, with discounts ranging from 5 per cent. to 25 per cent., according to the number of kilowatt-hours consumed per annum.

We are also prepared to furnish power in large quantities—that is to say, 1,000,000 kilowatt-hours or more per annum—at the rate of ·065M. (·77d.) per kilowatt-hour, under the following conditions. The current is supplied during the year, 24 hours per day, except during the months of November, December, and January, when, at the option of the central station, the current can be cut off during the time of maximum load—that is, from 4 p.m. to 8 p.m. At this rate, ·065M. per kilowatt-hour, we still have a profit (assuming, of course, that the cost is figured on the basis, case 2), and the advantage of having a constant load upon the station.

The Niagara Power Company offered the city of Buffalo the horse-power hour per annum (24-hour power) for £4, and the arc light per annum at the rate of £10. The difference in these prices perhaps indicates that the Niagara Company is figuring on some such basis as above mentioned. It would be interesting to learn whether the exceptional price of ⅛d. was not given for other considerations—in the case of the aluminium works, as a consumer of an otherwise waste product; in the case of the city of Buffalo, as a consideration for receiving a valuable franchise.—

Yours, etc.,
G. J. MELMS,
Director, Städtisches Elektricitätswerk.

Frankfort-on-Main, July 17, 1895.

[We print the Frankfort schedule of prices for electric lighting and power in another column.—ED. *E. E.*]

THE CENTRAL LONDON RAILWAY.

An undertaking which will give employment to large numbers of all classes who occupy themselves with railway construction is on the point of being commenced. It is an underground line, which will run from Shepherds Bush, where Goldhawk-road and Uxbridge-road meet, to Liverpool-street; and it will be known as the Central London Railway. It is to be made on the Greathead system. Electricity is to be the motive power.

A Bill for the construction of an underground railway from Oxford street to the City was brought in as far back as 1864, but was thrown out by a joint committee of the two Houses of Parliament. It would naturally have been made, like the Metropolitan Railway, on the "cut and cover" system; and it was to have passed under Oxford-street and Holborn. A similar Bill, for a railway from the Marble Arch to Whitechapel, was brought forward in 1872. This was rejected because the committee did not consider that it would be possible to raise the capital, which was put at £6,400,000. In 1890 an electric railway from the City to Queen's-road, Bayswater, was proposed, but the Bill did not pass the Upper House. However, in 1891, the Central London Railway Act, for a line from Shepherds Bush to Cornhill, became law; and in 1892 an additional Act with the same title authorised the extension of the line to Liverpool-street, and the construction of an underground station in front of the Royal Exchange.

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The line will be 6½ miles long, and will run at a depth of about 80ft. below the surface of the ground. There will be 14 stations, at each of which cylinders will be sunk, through which the spoil can be removed and the cast-iron segments for the cylinders lowered; so that, if necessary, 26 shields could be used, and work carried on at 26 faces simultaneously. Unfortunately, the spoil will all have to be removed by carts, water carriage, which is of such immense advantage to the contractors of the Waterloo and City Railway, not being available. Borings have shown that the work will be entirely in the London clay, and it is not likely that compressed air will be required anywhere. There will be separate tubes for the up and down lines; these will be 11ft. 6in. diameter, which is a mean between the sizes of the City and South London and the Waterloo, the former being 10ft. 6in. diameter and the latter varying from 12ft. 1¾in. to 12ft. 9in. In gradients the new line will have the advantage over its predecessors, as the steepest incline against the load will be 1 in 100, compared with 1 in 60 at the Waterloo and City, and 1 in 30 at the City and South London. The weight of rail which it is intended to use will be 100lb. per yard. The style of cars will be like those on the New York Elevated Railroad. In these there is a wide passage at each end, with seats placed back to the windows, as in an omnibus. In the centre of the car the passage is narrower, and the seats are arranged in groups of four, as in an ordinary American railroad car. They will be mounted on bogie trucks, and will weigh nearly 13 tons each. The seating capacity of each car will be 48, and a train will consist of six or seven cars.

The City terminus of the line will be at Liverpool-street, just under the Great Eastern terminus. It will thus be possible to connect it by subways with the Great Eastern Station, of which the suburban traffic is estimated at 80,000,000, with Broad-street Station, which conveys 26,000,000 passengers annually, and with Bishopsgate Station of the Metropolitan. Passing under the latter, the line will run beneath Old Broad-street and Threadneedle-street, and along by the Stock Exchange, to the Bank Station. There is more traffic along Mansion House-street, as the short length of road between the Mansion House and the Union Bank is named, than in any other part of London, and it is beneath this that the new railway will pass. The whole of the roadway from Princes-street to Lombard-street, and from the Mansion House to the Royal Exchange flags, is to be excavated, and supported on columns, girders, and arches. The cavern thus formed will be egg-shaped, and will have a subway 15ft. wide running all round it. Two staircases terminating in passages will lead to this subway from the Exchange flags—the one close to Threadneedle-street, and the other bordering on Cornhill. There will be two other staircases, which unite in one long passage from the Poultry and Walbrook sides of the upper end of Queen Victoria-street. Besides these, there will be staircases leading to the subway at the Union Bank, corner of Princes-street, the north-east corner of the Mansion House, and the junction of Lombard-street with Cornhill. In consideration of the company obtaining permission to construct their station at this site, the public are to be allowed to use the staircases and subway, thus saving delay both to the pedestrians and to the vehicles, which have to be stopped to allow them to cross. The public subway will be about 20ft. below the street level, and below it will be another subway of the same width, in which water and gas pipes, telegraph, telephone, and electric light cables will be collected, so that it may never be necessary to break up the roadway in order to make any repair or addition to these. The station will be at a level about 10ft. below the subway which surrounds it, and with which it will be connected by broad staircases on the north and south. Besides a spiral staircase there will be four direct-acting lifts to take passengers down to the platform level, 65ft. below. The Bank Station, with its subways, staircases, and other accessories, will be the first part of the work which will be commenced, and it will be put in hand very shortly. Besides the Central London, it will serve for three other electric railways: it is to be the terminus of the Waterloo and City, the City and South London is to be extended to it from the Monument, and the line from Islington, which has received parliamentary sanction, will also be brought to this point.

After leaving the Bank Station, the Central London Railway will go under the Poultry and Cheapside, and then with a short curve into Newgate-street, where there will be a station behind the new building of the General Post Office. From Newgate-street it will pass under Holborn Viaduct to the next station, at the top of Chancery-lane. There will be a station at the commencement of New Oxford-street, called after the British Museum, and another at Tottenham Court-road, where the line will possibly connect with an electric railway which has been authorised from Charing Cross to Hampstead.

At Oxford-circus Station it is proposed to make connection with the "Baker-street-Waterloo" electric railway, and thence the line will continue under Oxford-street and Bayswater-road through Davies-street Station, just past New Bond-street, the Marble Arch Station, at the top of Edgware-road, Westbourne Station, close to the head of the Serpentine, and Queen's-road Station, at the top of the road of that name. At the next station, Notting Hill-gate, it will probably be connected by subway with the District Railway Station of the same name. There will also be a station at Holland-park, and then the terminus at Shepherds Bush is reached; this adjoins the Uxbridge-road Station of the Outer Circle, used by the Great Western, North-Western, and South-Western, and connecting with the Metropolitan and the District Railways.

The generating station is to be at the Shepherds Bush end of the line, and it will be possible to deliver coal direct from the trucks of the Great Western or North-Western Railways to the boilers. Triple-expansion condensing engines are to be used, the total horse-power being about 2,900. The dynamos will be direct current, low tension, at about 500 volts. The current will in the first instance be sent through the tunnels by a main conductor or copper cable, which is insulated, and placed clear of the line altogether. It is connected at intervals with the working conductor, which is a channel of steel, resting on blocks of glass, placed on the sleepers. The feed from the main conductor to the working conductor passes through the signal-boxes, so that the signalman can cut off the current from his section in case of emergency. The motor in front of each train picks up the current from the working conductor through shoes or brushes which slide over it. The current is carried back by means of the rails themselves, the ends of the rails being connected by copper strips to ensure electrical contact.

The engineers of the line are Mr. J. H. Greathead, Sir John Fowler, and Sir Benjamin Baker. The total cost will be about £3,000,000. The contract to construct the whole of the work and to provide the rolling-stock has been taken by the Electric Traction Company, Limited, of 16, Great George-street, Westminster; but it has not yet been settled into how many sub-contracts the work will be divided.

It is expected that the whole journey will take 25 minutes, of which the time from Oxford-circus to the Bank will be 10 minutes, including stoppages. The trains are to run at intervals of 2½ minutes, and when at full work there will be 25 trains in motion, each consisting of seven cars. This gives 336 people per train, and if the railway were to work for 16 hours per day during 333 days in the year (reckoning Sunday as one-third of a day), it would be able to take 85 million passengers over the whole distance. From this the company infer that, after allowing for one-way traffic, etc., they will easily be able to accommodate 100 million passengers per annum.

SOME USES OF CURVES IN ELECTRICAL PRACTICE.

BY H. H. SIMMONS, A.I.E.E.

(Continued from page 36.)

The commonest curve met with is a straight line. This statement may seem somewhat paradoxical at first sight, but a curve, mathematically, is any line in which the position of every point can be represented by an expression in terms of the co-ordinates used. The purpose of these articles

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will be best served by adhering to what are known as Cartesian co-ordinates—that is to say, that method of expressing the shape of a line which we have already given. For the present, at least, we shall therefore describe the position of a point by reference to the two straight lines at right angles to one another, called O X and O Y above, and known respectively as the axis of X and the axis of Y.

We must first see that the position of a point in a plane is defined *exactly* by these means. We are given the two datum lines, O X and O Y, drawn on a sheet of paper, and by means of these are required to define the exact position of a point on that sheet. We must imagine the sheet of

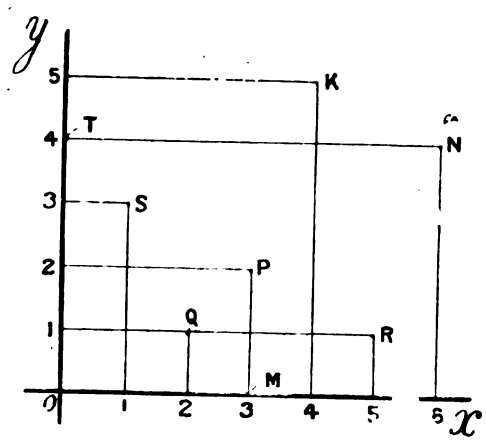

FIG. 5.

paper infinitely large, and the axes of X and Y each to extend to infinity in both directions, but their position in space fixed. The point where they cross, or "cut," one another is evidently a fixed point in space. We are thus in possession of a fixed point and two fixed directions in space. In Fig. 5, if we had to describe the position of point P, we should do so most accurately by saying that it was the point of cutting of two lines, one parallel to O Y, and cutting the axis of X at a distance of 3 from our fixed point, O, and the other parallel to O X, and cutting O Y at a distance of 2 from O; 3 is called the X ordinate and 2 the Y ordinate of P.

These two lines can only cut at this one point. Take an illustration: A man finds that from a certain spot in his field he can obtain a view of some particular object, and wishes to note the spot. His hedges run exactly at right

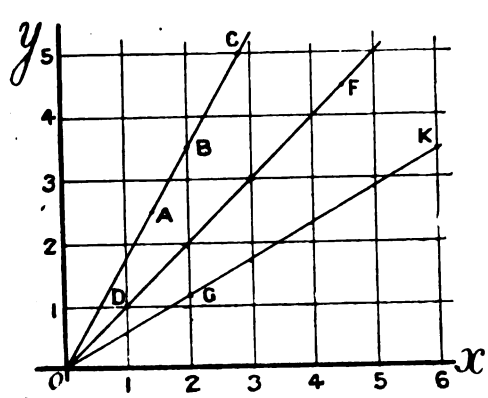

FIG. 6.

angles; he finds that by starting at a corner and walking 200ft. along one hedge, and then in a direction at right angles with it (*i.e.*, parallel to the other hedge) for 15 yards, he arrives at the spot. Any man to whom he tells this can find the spot by following those instructions. He has defined the spot exactly. A glance at Fig. 7 will show that points can be just as exactly defined if the hedges (or axes) are not at right angles. Also, it must be clear that he can arrive with just the same certainty at the spot by walking 15 yards along the other hedge first and then 200ft. parallel to the hedge by the side of which he originally walked. Or two men would find the spot by taking up positions at the hedges 15 yards and 200ft. respectively from a corner, taking care to keep the right distances for the right hedges, and walking out into the field each at right angles to his hedge; the spot where their paths crossed would be the spot with absolute certainty. If the contour of the field did not change, a man having these instructions could find the exact spot without any possibility of error hundreds of years after. This method then is exact.

If we wish to describe the position of the points, P, Q, R, S, T, M, N, K, in Fig. 5, we have only to give the distance of the point from O along each of the axes of reference O X and O Y. It is usual to do this as follows: P is the point (3, 2); Q is (2, 1); R is (5, 1); S is (1, 3); T is (0, 4); K is (4, 5); M is (3, 0); N is (6, 4). The invariable custom is to write the figure expressing distance along O X first and the distance along O Y next, and to separate the two by a comma. In Fig. 7 are given points which have the same notation, but with reference to two axes, O X^1 and O Y^1, which are not at right angles to one another, the points are obviously not the same as those in Fig. 5 if the point O is the same; but it is evident that the identically same points *could* be expressed by reference to either pair of axes. This latter method has little value and will not be again referred to. The question may arise, "How are we to represent a point which is below O X or to the left of O Y or both below O X and to the left of O Y?" To meet this contingency, all distances measured to the left of O along the direction of X O produced through O (we state it thus for clearness' sake; the axis of X is really infinitely long in directions both left and right of O) are called negative, as are also

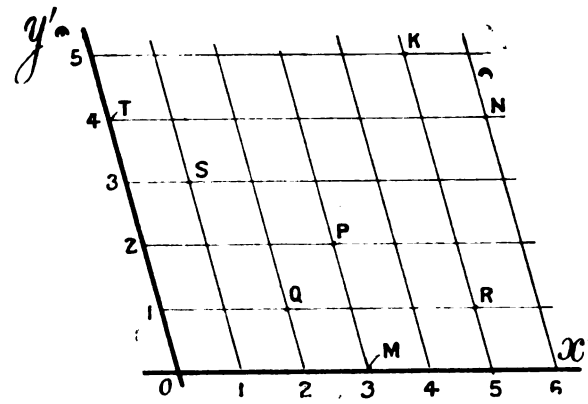

FIG. 7.

those distances measured below O in the axis of Y. We can therefore write something to mean any point we wish.

A line is an infinite number of points side by side; can we write down something which shall mean a line? Let us take a straight line first. In this work the scales along X and Y must always be equal, or we should be landed in endless confusion, but we have seen that in curves which represent facts the scales may be just whatever we choose to make them; just now we are not representing facts, but studying curves.

Can we write something which shall mean the line O D E F in Fig. 6? The point O is (0, 0); the point D (1, 1); the point E (3, 3); the point F (4·5, 4·5); of all these points the X ordinate is of the same value as the Y ordinate. Moreover, all such points would be on the line O D E F, as we see at once by filling in the points (2, 2); (4, 4); and (5, 5). Let us write $x = y$, meaning by "x" the X ordinate, and by "y" the Y ordinate. What can we take this to mean? It must mean more than a single point, for we need only write two *figures*, such as (1, 1) to mean a single point. But the letters x and y may be used as "variables" in this work, as in algebra, and with the most elementary knowledge of algebra we are aware that the expression $x = y$ is called an equation; that all letters and figures to the left of the sign = make up together what is known as "the left-hand side of the equation," and those on the right "the right-hand side"; also that when we have only x on one side and all other terms on the other side, we can without delay get a numerical value for x when the

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numerical values of these terms are known to us. If we find among these terms a variable, say y, our equation informs us that we may substitute for y any number we like; the equation gives us what the value of x will be when y has the value we assign to it. Therefore, our equation above tells us simply that, no matter what value we give to y, x has the same value. Obviously, then, if x means the X ordinate of a point and y its Y ordinate, this equation describes as many points as we can think of values to give to y. This number is infinite. The equation $x = y$ describes, therefore, an infinite number of points whose X ordinates and Y ordinates have the same value. If we find a lot of such points on the paper and join them, we get the straight line O D E F. This is not a mathematically rigid proof, of course—we do not desire one—but it suffices for the scope of these articles to show how at least this one line may be expressed by an equation. Briefly, $x = y$ now has a definite meaning for us. It is, of course, evident that O F is only a part of the line $x = y$; $x = y$ is a line whose extent is only limited by our power to give values to x or y.

(To be continued.)

NOTES ON THE RECONSTRUCTION OF A SMALL CENTRAL-STATION PLANT.*

BY FRANKLIN L. POPE.

The financial condition of the smaller central-station electric lighting plants throughout the country is at the present time by no means satisfactory, and in too many instances cannot even be truthfully said to be encouraging. A survey of the field shows that very few such plants located in towns having less than 10,000 inhabitants are earning more money than is necessary to meet their operating expenses and to provide for indispensable current repairs. In the State of Massachusetts, in which the operations of all electric lighting companies are by law made a matter of public record, it appears from the latest reports that the aggregate liabilities of the 57 companies operating in that State, including stocks, bonds, and floating indebtedness, amounted on June 30, 1894, in round numbers, to 14,000,000dol., nearly all of which stands charged to construction account. The net earnings for the preceding year were 1,000,000dol., or about 7·1 per cent. on the total investment—a sum obviously quite insufficient to provide for depreciation and at the same time pay a fair dividend on the capital which has gone into the business. But if half-a-dozen of the larger plants, in cities like Boston, Lowell, Worcester, Springfield, Lynn, and Fall River, were excluded from the list, the showing for the smaller plants would be even far worse than it now appears.

Many of these small plants were started at an earlier day than could have been justified by any reasonable estimate of the business then in sight, and now find themselves hampered by inconvenient buildings and with unsuitable machinery bought at high prices and encumbered with defective business methods, which experience has shown to be wholly inconsistent with the dictates of good judgment.

With the owners of many of these plants, it has become a very serious question whether the easiest way out of the dilemma which confronts them may not be to relegate the entire plant to the junk shop and the scrap-pile, and commence over again with new buildings, modern machinery, and improved methods of administration. When the necessary capital is readily forthcoming, there can be no doubt that this would often be the wisest course of procedure, but for obvious reasons it is one which is not always nor even usually practicable. The alternative is to remodel the existing plant, bringing it as nearly as may be into accordance with the best modern practice, and utilising so far as possible the old material, a course which at least has the merit of avoiding an undue expansion of the construction account—in most cases already sufficiently burdensome.

Having been called upon during the past year to advise the owners of a plant of the character above referred to in reference to certain changes which had been suggested as desirable, and having afterwards been employed in a professional capacity to design the work and superintend its execution, I have thought that some account of what we undertook to do, and how we did it, might not be without interest to the members of the institute.

The Great Barrington, Mass., Electric Light Company was organised and commenced business in 1888. The population of the district intended to be served was about 3,000, and most of the expected consumers were located within 2,000ft. of the point decided upon for the station. This was built of wood in the most inexpensive manner possible, and was placed alongside the railroad for convenience in receiving coal, although at the same time the danger from fire was materially increased. The original outfit was an Edison three-wire, equipped with a pair of 250-light 110-volt dynamos, and the company commenced business with 281 lights on contract at 10dol. per year each, wiring free. The centre of distribution was 1,800ft. from the station, necessitating over a ton of copper in the feeders alone. Generally speaking, the plant was well laid out and well built as things went in those days. The two dynamos were belted to a single 80-h.p. Armington and Sims engine. The original cost of the plant was about 16,000dol. The following year a Schuyler arc plant for street-lighting was added, carrying 35 arcs, nominally of 1,500 c.p., which was run from the same engine and boiler. In 1890 the plant was considerably enlarged by the addition of a second arc machine, a Westinghouse 500-light alternator, and a second engine and boiler of the same capacity as the first. An 80-kilowatt Westinghouse dynamo of more modern type was afterwards substituted for the original one.

Upon examining the plant last year, I found the Edison machines carrying on Saturday evenings a maximum load of some 450 lights, while three evenings in the week (with the stores closed) it fell to perhaps half that amount. The two Schuyler machines, with an aggregate capacity of 55 to 60 lights, were carrying about 38 to 40, or an equivalent of that amount, while the Westinghouse machine was seldom as much as half loaded, carrying a maximum of possibly 500 lights during three or four months of the summer season, and not much more than one-fourth that amount the remainder of the year. Necessarily, with so many dynamos of different types and with such a variable, yet small, average output, the consumption of coal was excessive as compared with the light delivered and paid for.

The street lines, according to the usual practice, were of No. 6 Brown and Sharpe weather-proof wire, the poles were of cedar of good size and fitted with pine or spruce cross-arms, with common green glass insulators set upon wooden pins. In consequence of a silly prejudice which had been fomented amongst the citizens by interested parties against permitting poles to be set in the streets, the wires, in a very great number of instances, had been attached, by cross-arms or brackets, to the trunks of the immense elm trees with which the streets of the town were shaded—a practice which occasioned an enormous loss of current every wet night, as well as much irregularity in the performance of the lights. The effect on the trees was by no means salutary, while the appearance was as much worse than that of poles in the streets as could possibly be imagined.

The village of Great Barrington extends for the most part along a single broad thoroughfare for a distance of nearly three miles, and the street-lighting circuits are consequently very straggling. The 1,500-c.p. lamps, which were suspended at intervals of 800ft. to 1,000ft., were actually of very little service in illuminating the densely-shaded streets.

After a careful consideration of the situation, keeping in view the greatest possible reduction of present and future operating expenses, it was determined that the wisest course to pursue would be to consolidate the whole service so that it could be supplied by one dynamo, in place of five underloaded ones. In pursuance of this plan it was decided to adopt the two-phase alternating system, at a maximum pressure of 2,100 volts in the primaries, and 105 volts in the secondaries, with a frequency sufficiently low to permit the advantageous use of induction motors if

* Paper read before the American Institute of Electrical Engineers, Niagara Falls, June 27, 1895.

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required. It was furthermore decided to abandon the steam plant, and to make arrangements to utilise some one of the excellent water powers which were available within practicable distances. Under ordinary circumstances, I should have hesitated to recommend the substitution of water power for steam as the sole source of power for the operation of an electric lighting plant. Water power is an invaluable auxiliary, and when conveniently available for use in conjunction with steam, may often be made to save a very large coal bill in the course of a year. On the other hand, the excessive fluctuations to which it is subject—which are scarcely realised by those but casually acquainted with the subject—render it in most cases a very uncertain reliance for a business which is compelled to go on, perforce, every night in the year, and which cannot suspend operations, as an ordinary manufactory does, if worst comes to worst, for a week or two at a time. Even a water privilege which, during 10 months of the year, furnishes twice as much power as is needed, and even more, may be expected to fall off during one of the extraordinary dry seasons which occur at intervals of from five to ten years to one-third its usual amount. In such a case, an electric plant solely dependent upon water power would find itself in a most undesirable predicament.

In the present instance, the choice of a water privilege finally reduced itself to two sites, one in the town itself, within half a mile of the centre of consumption, and the other at Glendale village, seven miles distant, both situated on the Housatonic River. The privilege first mentioned being already occupied by a woollen factory, only the surplus water was available, but this was known to be quite sufficient for the requirements of the electric company at least nine months in each year, leaving three months to be run by steam. It had the advantage of being close at hand, and was capable of being fitted up at a moderate cost. As to the Glendale privilege, it was necessary to be very sure that the lowest water of a dry summer would give all the power required to run the plant without the aid of steam. Having invariably found the value of a water power to be greatly exaggerated, not only in popular estimation, but in the opinion of its owners, the matter was investigated with much care. From the official State map of Massachusetts, it was ascertained that the area of the drainage basin of the Housatonic above the Glendale dam was 269 square miles. J. T. Fanning, a leading authority, from an extended examination of the recorded observations on the rainfall and flow of the New England rivers, reaches the conclusion that a watershed of the area mentioned may be estimated to yield the quantities of water given below:

CUBIC FEET OF WATER PER SECOND PER SQUARE MILE.

Minimum (15 days of least summer flow)	0·25
Mean (120 days, usually July to October, inclusive)	0·90
Maximum (flood volume)	93·00

It will be noticed that the flow in extreme dry weather is less than one-third of that which may be depended upon through the remainder of the year.

The distribution of rainfall throughout the year should be studied. It is often materially modified by local geographical conditions. The diagram shows that the distribution on the headwaters of the Housatonic is quite different from the normal type of the north-eastern region. The same may be true of other rivers.

While this investigation was going on, it was discovered that actual measurements of the volume of water in the Housatonic River had been made in 1878 by the engineers of the New York Department of Public Works, with reference to its utilisation as a future source of water supply for that city. The minimum summer flow was found to be (as given in the engineer's report) 0·34 cubic foot per second per square mile. It was also learned that measurements made on several different occasions at Birmingham, Conn., in very low stages of water, gave an average of 0·32 cubic foot per second per square mile. It was, therefore, assumed that Mr. Fanning's estimates were at least on the safe side. The greater volume of water found by the actual measurements is doubtless due to the fact that there are some five or six square miles of reservoirs, consisting of natural and artificial lakes, on the upper waters of the Housatonic, which are drawn upon by the numerous mills on the river as an extra supply during the season of drought.

A minimum flow of 0·25 cubic foot per second per square mile would give at Glendale 4,035 cubic feet per minute. Multiplying this by the weight of a cubic foot of water (63·3lb.) gives 255,415 foot-pounds, which, divided by 33,000, gives 7·74 gross horse-power per foot of fall, or a total of 99·6 h.p. for the 13ft. fall at Glendale. The average efficiency of a good turbine may safely be taken at 75 per cent., which would give 67·9 as the available horse-power during the whole 24 hours, in time of lowest water. In electric lighting, however, the great bulk of work is done within a period of about four hours (in summer time), and hence it is possible, in case there is sufficient area of pondage above the dam, to increase this capacity by storage at least fourfold, which would raise the limit of minimum available power during lighting hours to 271·6 h.p., an amount which was considered to be ample to meet all the probable requirements of the Great Barrington plant for many years to come.

While negotiations were still pending with the owners of the Glendale privilege, and also the one in the village already referred to, overtures were received from a manufacturing company owning a third exceptionally desirable privilege on the same stream at an intermediate point considerably nearer than Glendale. This company had only recently completed a new dam, head-gates, raceways, etc., at a very considerable expense, and was willing to lease the complete establishment, including a new McCormick turbine of 325 h.p. and a two-phase Stanley generator of corresponding capacity, at a monthly rental based upon the actual output as measured in kilowatt-hours at the dynamo terminals, provided that a certain minimum monthly consumption was guaranteed. With the same volume of water as at Glendale, the fall at this point was 20ft., assuring at least 417 h.p. at lowest water during lighting hours. All the hydraulic apparatus and appointments were of the best possible construction, and well calculated to ensure absolute permanency of operation.

The minimum rental required was somewhat less than the amount of the coal bill of the Great Barrington company for the preceding fiscal year, but while the immediate saving in operating expenses was not large, the acceptance of the proposition would place the company in a position to reduce its rates to consumers, for the reason that its output might be very largely increased without materially augmenting its operating expenses. A lease for a term of years was accordingly closed.

In laying out the plant it was determined to bring the main feeders directly to a distributing station in the village to be used principally as a convenient headquarters for testing the circuits and controlling the street-lighting service. In laying out the transmission line a surveyor was employed, and a preliminary line was run directly from the power-house to the distributing station. The air-line distance was found to be 5·15 miles. With the assistance of the surveyor the actual line was then staked out, going directly across country and keeping as near as circumstances permitted to the transit line. About half the distance the transit line was found to so nearly coincide with existing highways that the consent of the local authorities was obtained to set the poles along the highway location; the remainder of the route lay principally through uncultivated land of little value, so that a comparatively small expenditure was sufficient to secure a release from all claims for land damages. This enabled the line to be located with long stretches absolutely straight, avoiding all sharp angles, a very important consideration when heavy wires are used. The poles were of selected chestnut with natural butts, usually set 5ft. in the ground at maximum intervals of 125ft. The poles were ordinarily 25ft. long and 8in. thick at the small end. Shorter poles were sometimes used on elevations and longer ones in depressions, in order to equalise the strain as much as possible. The insulators used were of the large double-bell white porcelain type (German Government standard), and were imported by us from Berlin. The insulator of the top wire is set upon a malleable iron stem 14in. long screwed into the top of the

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pole, which is tapered to 5in. diameter and protected from splitting by driving on a wrought-iron ring. The tapered part of the pole, as well as the top, was given a coating of mineral paint mixed as thick as it could be spread with a brush. The insulator of the second wire is carried on a malleable iron goose neck, screwed into a $\frac{5}{8}$in. hole bored in the side of the pole, in such position as to bring the wires about 16in. apart. Another hole was bored on the opposite side of the pole, intended to take the goose neck of the third wire at some future time, leaving the same interval between the second and third wires. The porcelain insulators are fixed to their iron supports by a packing of oakum placed between the screw threads, which serves to prevent any danger of breakage by expansion or contraction. The line wire is laid in a groove formed in the top of the insulator, except upon the curves and angles, in which case it is tied at the side in a circumferential groove, as is usual in this country. The German method of tying is quite complex and unnecessarily strong; in case of undue strain, if anything gives way it had best be the tie wire. We therefore devised a simple tie which was easily and quickly applied, and which has so far served an admirable purpose. We were obliged to string the wires during very cold weather; sometimes as cold as 8deg or 10deg. below zero, and hence it was necessary to strain them very tight. A block and fall and a well-trained horse were used in pulling up, usually six or seven spans of one wire at a time. The hook of the block was always attached to the copper wire, whether bare or insulated, with a chain knot made of $\frac{3}{4}$in. rope. The feeder wires were of No. 3 Brown and Sharpe soft copper, covered with weather-proof "insulation" along the highway (as a concession to enlightened public opinion), but elsewhere bare. The lengths of wire were joined with McIntyre twisted couplings; the unusual strain we had to put upon them occasionally pulled one apart, and this led us, out of abundant caution, to solder them, although this was done for mechanical rather than for electrical reasons. Only two feeder wires have as yet been strung, providing for a single-phase current from one side of the two-phase generator, but it is the intention to run a third feeder hereafter, which will enable two-phase induction motors to be connected to the same distributing system.

A pair of telephone wires of No. 12 steel were strung below the feeder wires, and these were supported upon small German porcelain insulators on iron goose necks on opposite sides of the poles. These wires were transposed at intervals of about a mile, in order to eliminate the inductive effects of the alternating current in the feeders. The feeder lines were carried under the railroad at an undergrade crossing by placing the insulators upon iron brackets leaded into the stone abutments. The plan of construction above described makes a strong, handsome, and durable line, while the insulation of the circuit, even in the worst of weather, is simply faultless.*

The system has been planned to deliver the current at the distributing station at a uniform pressure of 2,100 volts. Two distributing centres were fixed upon in the old Edison three-wire network, and at each of these points a pair of large transformers, having a ratio of 20 to 1, were fixed upon a pole, with their respective primaries in series between a pair of branch feeders from the distributing system, and their secondaries were coupled in series in like manner with the neutral wire between them. None of the consumers on the old Edison system knew when the change had been made to the new service from anything they were able to notice in the behaviour of the lights.

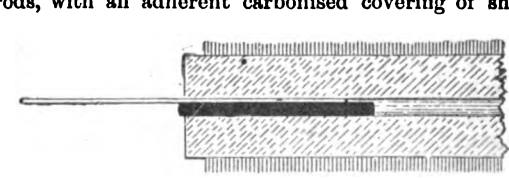
The next thing done was to reconstruct the street-lighting system. In place of the 36 arcs of 1,500 nominal candle-power formerly in use, we substituted 126 incandescent lamps of 50 volts and 32 c.p., placed in Iona fixtures projecting horizontally from the poles 14ft. above the ground. The lights, as a rule, were fixed uqon every alternate pole, but in the business centre, the street being broad, they were placed on each side at intervals of about 250ft., and staggered, so as not to come opposite each other. A Shallenberger shunt cut-out was applied to each lamp. The usual number of lamps in each circuit was 42, although we have since placed, in some cases, as many as 47 in one series without reducing the brilliancy of illumination sufficiently to be noticeable by anyone but an expert. One end of each street-lighting circuit is joined to a special feeder leading to the sub-station, where it is connected with the main feeder through a knife-switch. The other end of each lamp circuit is connected to any conveniently located branch feeder of the regular commercial lighting service. Each lamp circuit has, or will have, a fuse-block and cut-out enclosed in a weather-proof box at each end, where it joins the opposite feeders. These 32-c.p. lamps, when run at full candle-power, furnish a most satisfactory illumination and give the streets a very attractive appearance. So far as possible each lamp was located with the aid of a transit and level, so as to get them in absolutely straight lines both vertically and horizontally, a precaution which adds materially to the decorative effect. It is admitted by all that the streets of the town are much more satisfactorily lighted by the incandescents than they formerly were by the arc lamps, while the actual cost to the company is considerably less. The new lamps were cut in, one at a time, on the old arc wires, jumpers being temporarily placed across the terminals until everything was in readiness to discontinue the use of arc machines.

One of the most marked advantages of the series street-lighting system, especially when shunt cut-outs are used, is its great flexibility and convenience. For example, instead of placing from 40 to 45 50-volt lamps in one series, we may use 20 to 30 100-volt lamps, or if an odd number be required, less than is necessary to make up a circuit, the deficit may be supplied by adding extra shunt boxes in series at any convenient point in the circuit, until the pressure has been reduced to the required point. From time to time, as new lights are added, these spare shunt boxes are one after another brought into use in connection with them. Sometimes, also, we temporarily instal extra street lights by connecting them in parallel to the secondary mains of the regular commercial service, ultimately transferring them to new series circuits.

(To be continued.)

VELVO-CARBON.

The Battery and Motor Company, Limited, Bower-road, Victoria, N.E., send us a new list giving particulars of their velvo-carbon battery. We illustrate herewith a full-size section of the connection end of a 13mm. velvo-carbon rod for natural or chemical (gasing) depolarisation. These are hollow carbon core rods, with an adherent carbonised covering of short pile



cotton velvet. They are suitable for use as the negative electrode of a battery, employing either a simple sulphuric or a nitric solution. They are provided with a pure silver-wire connection. This connecting wire is held in position (and in perfect contact with the wax-protected end of the hollow carbon) by a rivet plug, which expands after being driven home.

* I regret that I am unable to present any actual measurements of the insulation of the line of the Great Barrington Company, no opportunity having occurred, since the work was completed, of making tests under atmospheric conditions of minimum insulation. Several years ago, however, while engaged in telegraphic service, I made a series of nearly 100 separate tests in rainy and foggy weather, extending over a period of five years, of a set of 10 porcelain insulators of the same make and pattern in every particular as those now on the Great Barrington line, erected on a house-top in the city, and therefore much exposed to smoke and dirt. These measurements gave a mean resistance of 28 3 megohms, and a minimum resistance of 19 megohms per insulator. On a metallic circuit, therefore, the minimum insulation resistance at each pole would be 38 megohms. On the Great Barrington line of 28,260ft., there are 250 poles and other supports, and hence we may assume that the minimum resistance of the insulation of the circuit as a whole would be 152,000 ohms. The current loss by leakage is found by dividing the mean voltage by the insulation resistance: $\frac{2,200}{152,000} = 0{\cdot}014$ ampere; an amount too small for serious consideration.

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NEW METHOD OF MEASURING ELECTRIC CAPACITIES, BASED ON THE SENSITIVENESS OF THE SKIN.*

BY H. BORDIER.

The principle of the method which I am about to describe is based upon an experiment by Prof. d'Arsonval.† If condensers of increasing capacity are placed successively in series on the same induction coil, and if we seek, either by the aid of a rheostat or by moving the coil by predetermined steps, the moment in which the least sensation produced by the current on the skin is perceived, it is found that this moment varies for each added capacity.

If we have, for example, a microfarad divided into tenths, it is easy to find two positions either of the rheostat or of the coil which correspond to the initial sensations produced by each tenth of microfarad added. In taking the capacities as abscissæ, and the different positions of the rheostat or of the coil as ordinates, a curve is obtained which represents the variation of the cutaneous sensitiveness with the different added capacities. This curve being established, it is sufficient to seek the moment of the appearance of the sensation produced by the faradic current, the coil being furnished with the condenser the capacity of which it is desired to know, and which can then immediately be read from the curve.

As is seen, this method utilises the minimum sensitive effect produced on the nerval terminations of the skin. If it is very difficult to appreciate the equality of two successive sensations, it is, on the other hand, very easy to distinguish the instant in which a sensation commences.

In order that the impressed surface and that the conditions of imbibition of the epidermis may remain the same during an experiment, it would be well to immerse the fingers in two basins containing water and connected to the two terminals of the induction coil.

Here is an example of the results obtained by this method. The coil used had a resistance of 668 ohms, the diameter of the wire was $\frac{1}{8}$mm., and its length 1,300 metres. The induction apparatus should be furnished with a Fizeau condenser, so that tolerably regular interruptions may be effected. Two wires go from the two terminals of the induction coil to two small crystallisers full of water, and at the bottom of which is a metallic plate. Immerse the index and middle fingers of each hand in the basins. We must first ascertain the position which the coil should occupy in order that the minimum sensation may appear—19·25 is found. A microfarad divided into tenths is then put in series, and the minimum sensation is experienced for the following positions of the coil:

Added capacities. Microfarad.	Position of the coil. Centimetres.
0·0	19·25
0·1	16·75
0·2	15 5
0·3	14·5
0·4	13 75
0·5	13
0·6	12 5
0·7	12
0·8	11·6
0·9	11·25
1	11

It may be remarked that in proportion as the capacity of the coil augments it is necessary to bring it gradually nearer and nearer. If the curve be constructed as mentioned above, it is found that all the points determined experimentally are placed pretty regularly on the same line. This result proves that the method is capable of supplying a tolerably close approximation.

The following are, in fact, the capacities found for two condensers: condenser *a*, 0·915 microfarad; condenser *b*, 0·91 microfarad. The ballistic galvanometer method furnished these figures: condenser *a*, 0·912 microfarad; condenser *b*, 0·915 microfarad.

The sensitive effects are not always diminished when the capacity of a coil is augmented. If the latter is a thick wire coil of low resistance, it will be found that the sensation becomes more powerful in proportion as the added capacities go on increasing. With a coil of 0·72 ohm resistance, the wire being 60 metres long and $\frac{13}{10}$mm. in diameter, I have obtained the annexed figures:

Added capacities. Microfarad.	Position of the coil. Centimetres.
0·0	9·5
0·1	10
0·2	10·4
0·3	10·8
0 4	11·25
0·5	11·7
0·6	12
0·7	12·5
0 8	12·9
0 9	13·4
1	13·8

It is here seen that it has been necessary to place the coil further away instead of bringing it nearer, as in the preceding case, in proportion as the capacity increased. However it may be, the method of measuring the capacities remains applicable in every instance.

There is a capacity which it is very interesting to know, and regarding which we have not very precise data—I mean the capacity of the body of man. The method which I have just indicated allows a very approximate measurement of this capacity to be obtained. The insulated object is placed in tension on one of the wires which connect the coil to the standardised condenser; a key or plug allows of the body being taken off the circuit or put in it. Results:

Added capacities at the coil. Microfarad.	Variations of the coil. 1st experiment. Centimetres.	2nd experiment. Centimetres.
0 0	20 00	19 25
0·1	17 75	16 75
0·1 + the body	17 7	16 7
0·02	16 75	15 5

In doing each curve on squared paper of large size, we find for the value of the capacity of the body: first experiment, 0·002 microfarad; second experiment, 0·003 microfarad; average value, 0·0025 microfarad. This capacity is about 58 times greater than that of a homogeneous conductor, the surface of which would be equal to that of the human body. We may be permitted to think that this capacity, relatively large, of the human body is due to phenomena of condensation occurring in the heart of the organism.

* Paper read before the Académie des Sciences, June 24, 1895.

† *Archives de Physiologie*, 1891, page 585.

LEGAL INTELLIGENCE.

CLAIM FOR ELECTRIC LIGHTING WORK.

In the Bloomsbury County Court on Friday, his Honour Judge Bacon had before him the case of Dawson *v.* Foster, in which the plaintiffs, Messrs. Dawson, Limited, electrical engineers, sought to recover payment of an account in respect of the installation of electric light throughout the defendant's house at Portman-square. It appeared from the evidence called on behalf of the plaintiffs, that the order for the work was given by the defendant's wife, but the husband had always been looked upon as the responsible party. When the work was completed, application was made to him for payment, but he denied liability on the ground that he never authorised his wife to give the order.

For the defence, **Mr. Foster** was called, and said he allowed his wife ample means to pay for general domestic expenses, and had absolutely forbidden her to pledge his credit in any way whatever. He was never even consulted in this matter, and therefore he did not consider he was liable.

His **Honour**, in giving judgment, said that cases of this kind were a great hardship on tradesmen, but they ought to be more careful to get the authority of husbands before carrying out orders which were given by the wife. He (the judge) had little doubt but that the defendant must have known that this work was being carried out, and no doubt he was enjoying the benefit of it, but in view of the evidence which had been given, he was afraid the plaintiffs could not recover, and therefore judgment must be for the defendant, but he should certainly not allow any costs.

WOOD v. WOODHOUSE AND RAWSON.

A summons for leave to institute proceedings in the action Wood *v.* Woodhouse and Rawson, Limited, appeared in Mr. Justice Vaughan Williams's list on Wednesday. At the rising of the Court, the case not having been reached, **Counsel** asked if his lordship would fix an early day for hearing the application. It

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was a case for consideration as to whether proceedings should be taken against the directors or not, and his lordship had directed a meeting of the shareholders to consider it. They had met, and it was desirable that the matter should be disposed of as soon as possible.

His **Lordship** directed application to be made to his clerk as to whether there was a vacant day, and if there was it would be given to this case.

ACTION AGAINST THE PRESCOT DISTRICT COUNCIL.

In the Queen's Bench Division, Mr. Justice Grantham and Mr. Justice Wright, sitting as a divisional committee, have heard the case of the British Insulated Electric Lighting Company against the Prescot Urban District Council, which was an application by counsel to mark the case urgent, and that it might be put into the list for next Monday. The Court granted the application.

BARCLAY v. NEW ZEALAND ELECTRICAL SYNDICATE.

On Saturday Mr. Justice North had before him a motion for judgment in a debenture-holders' action which came on by consent. So far as was known, there had only been one issue of debentures, which was for £30,000, and the plaintiffs held the whole of the issue. The company was formed to light the city of Wellington, in New Zealand, with electricity. The action was commenced last March, on the ground of jeopardy.

Mr. Justice North made an order that the plaintiffs were entitled to a charge, continued the receiver and manager, and directed the usual accounts and enquiries.

NEW BRITISH ELECTRICAL INSTALLATION.

Mr. Baker, in the action of Martin *v.* the New British Electrical Installation Contractors, Limited, on Thursday last week, asked Mr. Justice Kekewich to appoint a receiver and manager, describing the case as urgent.

Mr. Fawcus, appearing for the company, said they could not resist the application, and his **Lordship** appointed Mr. Lester, of Worcester, to the double position, but expressly refused to give any directions as the management.

COMPANIES' MEETINGS AND REPORTS.

WEST AFRICAN TELEGRAPH COMPANY, LIMITED.

The annual general meeting of the above Company was held yesterday at Winchester House, E.C., Sir Henry Mance, C.I.E., M.I.C.E., occupying the chair.

The **Chairman**, in moving the adoption of the report, stated that at previous meetings the results to ordinary shareholders had not been satisfactory, but there was now a better prospect. The death of Mr. Thomas Fuller, one of the directors, had occurred during the year, and he would be much missed. The chairman ran over the items of the account (an abstract of which was given in our last issue), and stated that there was a reserve of £21,000, and the directors had arrived at the conclusion that they should carry the whole balance of the net revenue to the reserve fund. This was the soundest policy to adopt. The revenue and the small amount of expenses in connection with repairs justified the payment of a small dividend. The Company was getting into a sound financial position, and the debentures were at a better price in the market. The reduction of the tariff to the Cape had given satisfaction to traders, and had proved of no disadvantage to the Company. Their cables were in good working order, the efficiency of the system had been improved, and the health of the staff was good. There was an increased revenue with a decrease in working expenses and in the loss by exchange.

Mr. J. D. Pender seconded the motion, which was carried unanimously.

The **Chairman** moved, and **Mr. J. D. Pender** seconded, the re-election of Mr. Robert Kaye Gray and the Hon. A. G. Brodrick as directors. The motion was adopted.

The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., were re-elected.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

Directors: James Staats Forbes, Esq., chairman; the Earl of Lichfield, Major Samuel Flood Page, Joseph Wilson Swan, Esq., F.R.S., Ernest Villiers, Esq.

Report of the directors to be presented at the ordinary general meeting of the Company to be held at the Cannon-street Hotel, E.C., on Monday, July 29, at 2 p.m.:

The profit and loss account shows a credit balance of £25,876. 3s. 2d. After providing for the interest accrued upon the £100,000 debenture stock, there remains a balance of £21,376. 3s. 2d. available for distribution. An interim dividend at the rate of 5 per cent. per annum having already been paid in respect of the first half-year ending December, 1894, a further payment at the rate of 5 per cent. per annum in respect of the second half is recommended, the balance of £3,702. 5s. 2d. being carried forward. The business of the Company during the year has been satisfactorily maintained, notwithstanding the severe competition which has set in since the expiration of the Company's patents. The liquidation of the Swan United Electric Light Company, Limited, is now practically completed, and the final meeting for winding up will shortly be held. The directors have to report the resignation of his seat at the Board by Shelford Bidwell, Esq., F.R.S., and the election in his place of Joseph Wilson Swan, Esq., F.R.S. The Earl of Lichfield and Ernest Villiers, Esq., retire by rotation from the Board, and offer themselves for re-election. Messrs. Welton, Jones, and Co., the auditors, offer themselves for re-election.

PROFIT AND LOSS ACCOUNT, YEAR ENDED JUNE 30, 1895.

Dr.	£	s.	d.
Stock on hand, July 1, 1894	87,768	7	1
Wages, purchases, etc.	85,112	19	9
Salaries, directors' remuneration, rent, office expenses, insurance, income tax, general and law charges	10,759	11	9
Depreciation on plant, etc.	3,512	17	3
Balance	25,876	3	2
	£213,029	19	0

Cr.	£	s.	d.
Sale of lamps, fittings, royalty on holders, etc.	114,890	1	2
Interest, etc.	2.156	6	7
Stock on June 30, 1895	95,983	11	3
	£213,029	19	0

Dr. BALANCE-SHEET, JUNE 30.	£	s.	d.
Share capital—5,000 A shares of £5 each, fully paid, allotted to the Edison Electric Light Company, Limited	25,000	0	0
12,139 A shares of £5 each, fully paid, allotted to the Swan United Electric Light Company, Limited, ranking up to 5 per cent. for dividend on the amount credited as paid up, and afterwards equally, per share, with A shares partly paid	60,695	0	0
89,261 A shares, £5 each, £3 paid	267,783	0	0
	353,478	0	0
23,564 B shares, £5 each, fully paid	117,820	0	0
4½ per cent. debenture stock	100,000	0	0
Sundry credit balances	11,527	5	9
Reserve fund	82,577	2	10
Profit and loss, as per appropriation account £25,876 3 2			
Less interim dividend, paid on March 20, 1895, £8,836. 19s., and interest on debentures for six months paid December 31, 1894, £2,250 11,086 19 0			
	14,789	4	2
	£680,191	12	9

Cr.	£	s.	d.
Cost of establishing the business, goodwill, remaining patents, etc., as per last balance-sheet	261,955	16	1
Further expenditure thereon	19,307	9	11
	281,263	6	0
Amount of B shares of this Company, issued as *per contra*	117,820	0	0
	399,083	6	0
Manchester Edison-Swan Company, Limited, £100,000 B shares at nominal cost	12,000	0	0
Freehold and leasehold property	57,806	6	9
Plant and stock	132,260	5	7
Debtors	41,609	8	7
Investment National Telephone Company, Limited, 5 per cent. non-cumulative 3rd preference shares at cost	25,000	0	0
Cash at bankers and in hand	12,432	5	10
	£680,191	12	9

EASTERN TELEGRAPH COMPANY, LIMITED.

The forty-sixth half-yearly ordinary general meeting of this Company was held yesterday at Winchester House, E C., the vice-chairman, the Marquis of Tweeddale, presiding in the absence of Sir John Pender.

The **Chairman**, in moving the adoption of the report and accounts for the half-year ended March 31, 1895, a summary of which appeared in our last issue, said that the revenue for the period amounted to £420,526, from which was deducted £98,060. 4s. 8d. for the ordinary expenses and £52,730. 0s. 2d. for expenditure relating to repairs and renewals of cables, etc., during the half-year. After providing £3,222. 19s. for depreciation of spare cable, £1,813. 5s. due to revaluation of currency assets, and £5,812. 4s. 7d. for income tax, there remained a balance of £258,887. 6s. 7d., to which was added £59,175. 16s. 6d. brought from the preceding half-year, making a total available balance of £318,063. 3s. 1d. From this balance there had been paid interest on debentures and debenture stock, £27,514. 12s. 8d.; dividend on preference shares, £20,296. 6s. 8d.; an interim dividend of 2s. 6d. per share on the ordinary shares,

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£50,000; total, £97,810. 19s. 4d., leaving a balance of £220,252. 3s. 9d., out of which the directors placed £9,000 to the reserve fund for maintenance ships and £100,000 to the general reserve fund. An examination of the message receipts showed that there was a small decrease in the traffic with India, a considerable increase in that with countries beyond India (Australia, etc), and a good increase in that with South Africa, doubtless owing to the activity in mining operations which has prevailed there for so long. He announced that the negotiations which had been conducted with the home authorities and the various South African Governments with respect to the continuation of the subsidies now payable for telegraphic communication with South Africa had been brought to a satisfactory termination. He had just received a telegram from Sir John Pender, in which he said: "Arrangements just completed with the Cape, Natal, and Transvaal ensure us 15 years' prosperous traffic"; the consideration being the lowering of the tariff. They had laid about 300 miles of new cable on the Bombay and Aden section. The property altogether was in a very prosperous condition, and the management was both efficient and economical. He moved that a final dividend for the year ended March 31, 1895, of 2s. 6d. per share and a bonus of 3s. per share, amounting together to £110,000, free of income tax, and making, with the three previous payments on account, a total distribution of 13s. per share, or 6½ per cent. for the year on the ordinary shares, be paid.

Mr. Nicholl seconded the motion.

The **Chairman** said, in reply to **Captain Goodsall**, that the 300 miles of new cable on the Bombay and Aden section were laid in different portions, but the last repairs were at the Bombay end; and, in reply to **Mr. Baines**, that they would be glad as soon as the reserve fund was sufficiently large to increase the dividends payable.

The motion was then unanimously carried, and a vote of thanks to the chairman concluded the proceedings.

GULCHER (NEW) ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

First annual report of Mr. Charles Fitch Kemp, the voluntary liquidator of the above-named Company, to be submitted to the shareholders at an extraordinary general meeting to be held at 73, Lombard-street, E.C., on Monday, July 29, at 2 30 p.m.:

In submitting my first report and statement of accounts I have to remind the creditors and contributories that the basis upon which I accepted the liquidation of this Company was, shortly, as follows: That each asset—viz., the stock-in-trade and plant, and a debt owing to the Company in New Zealand from the New Zealand Electrical Syndicate—would be sufficient to pay off the first debentures; that the uncalled capital of the Company would be sufficient to pay off the second debentures, and would probably provide a surplus of cash which would pay a substantial dividend to third debenture-holders; and that ultimately the unsecured creditors would be fully paid, and some return would be made on the share capital, when time had been given to realise the holding of the Company in the shares of the New Zealand Electrical Syndicate. This forecast of liquidation appeared at the time to be based on reliable grounds, but it has entirely failed of realisation, owing to two main causes, and the position now is that I have borrowed the sum of £3,000 on a transfer of the first debentures (which have otherwise been paid off), and that there remains due on that loan about £2,500, and that the only assets immediately available to meet that loan are the shares in Easton, Anderson, and Goolden, Limited, hereinafter more particularly referred to. The uncalled capital will not be sufficient to pay off the second debentures of the Company, and the realisation of the cash assets in New Zealand is indefinitely postponed. I have already said that there are two main causes which have led to this unfortunate result. The first and leading cause is the breakdown of the firm of Miles and Co., Limited. A director of that company was also a director of this Company, and he approved and endorsed the scheme for settlement of the affairs of this Company which was submitted to me, as before mentioned, but the keystone of the scheme was the payment by the contributories of the amount due from them, and Miles and Co., Limited, were responsible to this Company for no less a sum than £3,500, none of which I have yet been able to collect. Consequently, the claim of the second debentures, instead of being fully paid off and leaving a tangible surplus, remains unsatisfied, and unless, therefore, a very substantial dividend is recovered from Miles and Co., Limited, as to which I am unable to speak, I can see no immediate prospect of discharging them. The other cause is this: The plant of the Company in New Zealand was taken over by the New Zealand Electrical Syndicate as a going concern, and upon terms of repayment out of realisation which it was calculated would rapidly place this Company in the possession of funds. The debt was calculated to amount altogether to between £3,000 and £4,000, which would have been remitted from time to time as moneys were collected; but the New Zealand Electrical Syndicate had executed debentures on which default had not arisen, and which debentures were held by the Gas and Water Trust. The Gas and Water Trust, as holders of these debentures, procured from the New Zealand Electrical Syndicate, by vote of a majority of the Board, which had then control, a resolution in favour of the appointment of a receiver. Now, without encumbering this report with the details of disputes which arose between the shareholders of the Electrical Syndicate and the Gas and Water Trust, I was compelled to take steps to protect the interests of this Company in the assets of the syndicate, as I was advised that the syndicate's existence depends wholly upon the concessions and contracts it has secured in New Zealand and its Act of Parliament there, and that the appointment of a receiver might have a most disastrous effect upon all interests in the Company, whether of debenture or share capital. I thought that the gravity of the step taken by the Gas and Water Trust had not been adequately considered, and I instructed the solicitors acting for me in this liquidation to recall the shares to which I am entitled as liquidator, and which had been outstanding in the name of Mr. Roderick Pryor, and had been used by him for the purpose of qualifying as directors the nominees of the Gas and Water Trust. In this way I have reacquired some share in the control of the syndicate, but I have every desire and intention of co-operating with the Gas and Water Trust in the management, so as to duly preserve the interest of the debenture-holders and yet secure to the shareholders that value which I am advised and believe may be still considered to remain in their holdings. I see no reason to doubt that I shall succeed in this, and that ultimately the debt of £3,000 and upwards, and also the nominal capital exceeding £20,000 which I as liquidator hold in the New Zealand Electrical Syndicate will become valuable assets, but in the meantime the result of the disputes referred to has been so far adverse to the present realisation that the cash assets in New Zealand, which, when I entered upon my liquidation, I hoped to have received, prior to this date, still remain in that country, and there is no prospect of immediate remittance. I will now recall the attention of the contributories to the resolution which was passed at the meeting held on August 1, 1894, authorising me to enter into an arrangement with Easton, Anderson, and Goolden, Limited, for the sale to that company of the Company's plant, machinery, stock-in trade at the price of £12,500, payable as to £5,700 part thereof in cash, and as to £6,500, the balance thereof in 680 shares of £10 each, fully paid, in Easton, Anderson, and Goolden, Limited. I informed the gentlemen who were present at that meeting that I was advised not only that the offer was highly beneficial, but that the cash paid was alone greater than I could have expected to receive at a break-up price. The shares, therefore, were taken for what might be their value, it being well known that there was no market for them at that time, and that they were not earning dividend. The solicitors acting in this liquidation are also solicitors for Easton, Anderson, and Goolden, Limited, and they have procured for me from another client of theirs an offer of 5s. in the £ for these shares—that is, £1,700. There is no market for the shares, and I am not able to say anything as to their intrinsic value, but I do know that there is a very considerable issue of debentures in front of them. It is only therefore from those who are in some way interested in the Company that an offer can be obtained. If this meeting authorises me to accept that offer, I shall, after discharging the expenses of the liquidation to date, apply the moneys obtained in further reduction of the £2,500 which remains owing on the security of the first debentures, as it is obvious that until those first debentures are discharged there can be no payment to the unsecured creditors. In conclusion, I can only say, gentlemen, that while I do not take at all a despondent view of the ultimate realisation of the assets of this Company, I cannot hold out to you the hope that funds will reach my hands available for dividend at any early date.

STATEMENT OF RECEIPTS AND PAYMENTS FROM JUNE 4, 1894, TO JUNE 30, 1895.

Receipts.	£ s. d.	£ s. d.
Sales of stock and plant per Easton, Anderson, and Goolden, Limited...	12,500 0 0	
Sundries ...	30 12 8	
		12,530 12 8
(The liquidator was authorised to accept, as part payment of the above sum of £12,500, the transfer of 680 £10 shares in the Company at par, and cash £5,700—see *contra*.)		
Book debts ...		888 11 3
Loan from Lloyds Bank, Limited ...	4,000 0 0	
Less amount repaid to date ...	1,500 0 0	
		2,500 0 0
Calls collected (hypothecated to Lloyds Bank, Limited, as holders of second debentures—see *contra*) ...		1,429 1 4
		£17,348 5 3

Payments.	£ s. d.	£ s. d.
Preferential payments for rents, rates, salaries, etc.		520 1 1
First mortgage debentures, redeemed ...		5,289 16 4
Stamps and transfer fees on debentures ...		88 2 6
Easton, Anderson, and Goolden, Limited (see *contra*)—		
For 680 shares at £10...	£6,800 0 0	
Purchase of £3,000 second mortgage debentures at 97½ ...	2,925 0 0	
		9,725 0 0
Taxed costs in debenture-holders' action ...		182 13 10
Fire insurance and sundry incidental expenses ...		23 13 10
Lloyds Bank, Limited, interest on loan ...		66 18 5
On account of principal and interest due on second debentures held by them ...		1,392 5 7
Cash at bank—Liquidators' general account ...	22 17 11	
Call account (to be paid to Lloyds Bank, as above) ...	36 15 9	
		59 13 8
		£17,348 5 3

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TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.

On Tuesday the half-yearly general meeting of the above company was held at the offices, Old Broad-street, Admiral Sir G. H. Richards occupying the chair.

The **Chairman** said that the dividend which they had declared for a great many years at this period of the year—12s. per share, or at the rate of 10 per cent. per annum—would be paid to-day. The present year had not been a good one for the manufacture of telegraph cables, which, however, were not articles of every day use, and they did not look forward every year to obtain any very great telegraph work. It was, however, not at all an unusual thing occasionally to have a slack time in the manufacture of submarine cables. As regarded their general trade—the guttapercha work—it had been slightly better than it was at the same time last year.

No resolution was submitted to the meeting beyond the customary vote of thanks.

CITY AND SOUTH LONDON RAILWAY COMPANY.

Directors: Charles Grey Mott, Esq. (chairman), Harrow Weald, Middlesex; Charles Seymour Grenfell, Esq., Elibank, Taplow; Sampson Hanbury, Esq., Wyvenhoe Park, near Colchester; S. Barclay Heward, Esq., 96, Ashley-gardens, Westminster; Edwin Tate, Esq., 21, Mincing-lane, London, E.C.

Report of the directors, with abstract of accounts for the half-year ending June 30, 1895, to be submitted to the half-yearly ordinary general of the Company, to be held at Winchester House, Old Broad-street, in the City of London, on Monday, July 29, 1895, at 3 p.m.:

The receipts from all sources for the past half-year have amounted to £24,401. 15s 8d., and the cost of working has been £15,019. 16s., leaving a profit of £9,381. 19s. 8d. Inclusive of the balance brought forward from December 31 last, the net revenue account shows an aggregate total of £10,379. 8s. 8d. After making provision for the debenture and debenture stock interest, a balance remains available for dividend of £6,420. 16s. 2d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference shares, and that a dividend at the rate of 1¼ per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £964. 11s. 2d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season-ticket holders, carried since the opening of the railway in each half-year:

Half-year ended	Number of passengers (exclusive of season-ticket holders).	Receipts (including season tickets).
Dec. 31, 1890 (11 days)	165.000	£1,568 3 9
June 30, 1891	2,412,343	19,403 6 9
Dec. 31, 1891	2,749,055	19,798 16 6
June 30, 1892	2,813,162	20,931 4 2
Dec. 31, 1892	3,117,602	22,002 17 5
June 30, 1893	3 146,656	22,458 6 9
Dec. 31, 1893	3,093 351	22 067 14 10
June 30, 1894	3,383,154	23,564 10 6
Dec. 31, 1894	3,275,649	23,540 12 4
June 30, 1895	3,113,199	23,711 5 8
Total since the opening of the line	27,269,171	£199,046 18 8

During the first three months of the present year there was a satisfactory growth of the traffic on the line, but the very hot and fine weather of the last three months affected it so much that the increase was not only checked, but a small decrease resulted as compared with the same quarter last year. This was very disappointing, as your directors had confidently looked forward to a considerable increase in the traffic during the past half-year. Considering, however, the very large diminution which has taken place in the traffic of nearly all the railway companies in the kingdom during the same period, your directors are glad that the receipts still show an increase, however small. In accordance with the authority given at the last half-yearly meeting, detailed plans have been prepared for the extension to Finsbury-pavement, and negotiations have been entered into for the purchase of some of the property, but the arrangements are not yet sufficiently completed to enable a report to be made to the shareholders on the present occasion. During the past six months a further sum of £23,200 terminable mortgage debenture bonds has been paid off. The Bill for the extension of time for the works of the Clapham Extension Act, 1890 and for other purposes, received the Royal assent on May 14, 1895. A contract has been let for the construction of the new siding at Stockwell. This, when completed, will enable the work at that station to be carried on with greater economy and convenience.

Dr. Revenue Account.	£ s. d.
Maintenance of way, works, and stations	528 3 9
Locomotive and generating power	5,699 13 11
Carriage repairs	420 10 2
Traffic expenses	5,877 14 11
General charges	1,740 3 11
Passenger duty	110 9 2
Law charges	8 7 4
Rates and taxes	634 12 10
	£15,019 16 0
Balance carried to net revenue account	9,381 19 8
	£24,401 15 8

Cr.	£ s. d.
By passengers (3,113,199)	22,489 17 4
Season tickets (517)	1,221 8 4
	23,711 5 8
Parcels, etc.	64 18 4
	23,776 4 0
Transfer fees	26 2 6
Rent of property, net	519 17 2
Sundry receipts	79 12 0
	£24,401 15 8

Dr. General Balance-sheet.	£ s. d.
Balance from net revenue account	6,420 16 2
Unpaid interest and dividends	105 7 7
Interest payable or accruing and provided for	1,311 2 10
Sundry outstanding accounts	4,020 11 9
Balance from capital account	1,915 2 6
	£13,773 0 10

Cr.	£ s. d.
Cash at bankers—current accounts, £4,651. 5s. 3d.; and on deposit at interest, £5,000	9,651 5 3
Cash in hand	822 16 2
	10,474 1 5
General stores—stock of materials on hand	3,066 10 3
Sundry outstanding accounts	232 9 2
	£13,773 0 10

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ille-sur-Tet.—Le Mairie d'Ille-sur-Tet, Pyrénées-Orientales, invites tenders by August 11 for the concession of the electric lighting of the town.

Heywood.—Tenders are invited for relighting the U.M.F. Church, Hopwood, Heywood. The specification may be seen at Mr. Wm. Parker's, 2, Middleton-road, Heywood.

Brussels.—Le Gouvernement Provincial invites tenders by August 2 for a concession for the construction and working of a tramway from the Bourse in Brussels to Koekelberg and Jette-Saint Pierre.

Bradford.—Tenders are invited for the electric lighting of the mechanics' hall and saloon of the Bradford Mechanics' Institute. Particulars can be obtained of Mr. T. C. Hope, architect, 27, Kirkgate, up to 30th inst.

Paris.—L'Administration des Postes et des Télégraphes invite tenders by August 1 for the supply of paper-insulated cables in five lots. Specifications at Rue de Grenelle, 103 (Division du matériel et de l'exploitation électrique, 3e bureau).

Brighton.—The Corporation invite tenders by August 10 for the supply and erection at the electricity works, North-road, of evaporative brass-tube surface condensers, electrically-driven air-pumps, exhaust and condenser piping. Specifications can be obtained from the town clerk.

Frimley.—The Frimley Urban District Council invite tenders for the supply of 25 new lamps (complete). Particulars can be obtained from the surveyor, Mr. W. J. Hodgson, surveyor's office, Camberley. Tenders must reach Mr. A. M. Kennett, clerk, London-road, Camberley, by 29th inst.

Aylesbury.—Tenders are invited for lighting the public lamps and clock tower within the district for one year from September 1, for the Aylesbury Local Board. The conditions for lighting and all other particulars in connection therewith may be obtained on application to Mr. George Fell, clerk, Aylesbury, to whom tenders must be sent by August 9.

Cowes.—Tenders are invited by the Urban District Council for laying down an electrical plant of sufficient capacity to keep burning at the same time 2,200 8-c.p. lamps, and also for public lighting and the laying of mains to accommodate 3,000 lights at the same time. The length of the road to be lighted is about a mile. Particulars can be obtained from Mr. Nelson F. Dennis, A.M.I.C.E., engineer to the Council, Cowes. Tenders are to be delivered by August 27.

Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

Romford.—The Romford Urban District Council invite tenders for lighting the public lamps in the town of Romford, as to about 190 of such lamps from sunset to sunrise, during 12 months from September 1. Tenders to include the cost of lighting, cleaning, and repairing, and are to be sent to Mr. Geo. Bailey, clerk, Romford, by 4 p.m. on August 6. A contract and (if necessary) a bond with sufficient sureties will have to be entered into and given by the person or persons whose tender may be accepted. Further particulars may be had on application to the surveyor. No special forms of tender.

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Salford.—The School Board invite tenders for the installation of the electric light into their new offices, Chapel-street, Salford. Plans and specifications, with forms of tender, may be obtained from Mr. S. V. Clirehugh, A.M.I.C.E., Temple-chambers, Brazennose-street, Manchester, consulting engineer, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders, endorsed "Tender for Electric Light," and addressed to the chairman of the Board, must be sent in by 12 noon on 31st inst. Mr. Ogilvie Duthie, clerk, Town Hall Buildings, Salford.

London, E.C.—Tenders are invited by the Shoreditch Vestry for the erection of a chimney shaft 150ft. high. Specification, with form of tender and bills of quantities, can be obtained from and plans inspected at the office of the consulting engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, from 22nd inst., on payment of £2. 2s., to be returned on receipt of a bona fide tender. Trade union rates of wages and hours of labour to be observed. Sealed tenders, endorsed "Chimney Shaft Tender," to be sent by 4 p.m. on 29th inst. to Mr. H. Mansfield Robinson, clerk, Town Hall, Old-street, E.C.

London, W.—The Hammersmith Vestry invite tenders for complete schemes for public and private lighting, and for the supply of motor power in that portion of the parish of Hammersmith described in the provisional order as the compulsory area. Memoranda of instructions, with a map of the district, may be obtained from Mr. H. Mair, surveyor to the Vestry, on or after July 10, 1895, between the hours of nine and five, Saturdays nine and one, on payment of a deposit of £10, which will be returned to persons sending in a bona fide tender. Tenders are to be delivered at the meeting of the Vestry, at the Vestry Hall, at 6.30 p.m. on September 4.

Wakefield.—The Corporation invite tenders for the supply and erection of the following: section A—boiler-house plant (boilers and fittings, mechanical stokers and engine economiser, feed-pump, injector, etc.); section B—engine-house plant (steam alternators condensers, oil filter, fittings, etc., steam, exhaust, feed, blow-off, and sundry pipes, valves, and water-tank, etc.); section C—main switchboard and instruments; section D—underground work (cables, junction-boxes, culverts, and trenching, etc.); section E—sub-station fittings (transformers and switchboard, etc.); section F—arc lamps and posts; section G—meters; and section H—overhead crane. Particulars are obtainable from Mr. Robert Hammond, Ormond House, Great Trinity-lane, E.C., on and after August 2, on payment of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders are to be delivered by August 24.

Valletta (Malta).—Sealed tenders will be received at the office of the Receiver-General and Director of Contracts, Valetta, or at that of the Crown Agents for the Colonies, Downing-street, London, until 11 a.m. on August 1, for the supply of materials in connection with the installation of the electric light in the civil and war department buildings in Malta. The materials are comprised under four headings—viz., (1) cables and wires, (2) tools, etc., (3) fittings, fixtures, etc., (4) sundries. Printed forms of tender and of the specifications and conditions may be obtained on application at the above office, Valletta, or at the office of the Crown Agents for the Colonies, Downing-street, London. Each tender must contain the name of the surety whom the tenderer intends to propose for securing the performance of the contract and the payment of the penalties therein established. The surety to be a person residing in the island. No notice shall be taken of any tender not accompanied by a deposit, to be made in the office of the Receiver-General and the Director of Contracts, Valletta, or in that of the Crown Agents in London, of a sum of £5 sterling, to be forfeited to the Government should the party tendering or his surety, in the event of the tender being accepted, fail to appear for signing the contract within three days from the day of the notice given to them to that effect. If the tenderer is not resident in Malta, his tender must contain the name of an agent residing in the island, to whom, in the same tender, power must be given to represent the tenderer in the contract. Any tenders which may be delivered at the Crown Agents' office must be in sealed packets addressed to the "Director of Contracts, Malta—Tender for Materials for Electric Lighting," under cover addressed to the Crown Agents for the Colonies.

RESULTS OF TENDERS.

Brighton.—The following tender (the only one sent in) has been accepted by the Town Council for the supply and erection at the electricity works, North-road, of steam and feed piping, cast-iron storage tanks, feed-water filters, electrically-driven feed pumps, circulation economiser, coal-elevator, and sundries: J. Fraser and Sons, Millwall Boiler Works, London, E., £3,220.

Bedford.—The following tenders have been accepted by the Electric Light Committee for supply and erection of the following plant: (Section A) two water-tube boilers; (B) two 140-b.h.p. double-acting compound enclosed engines; (C) two 90-unit alternators, with stationary armature: Babcock and Willcox, Limited, two water-tube boilers, £960; W. H. Allen, Son, and Co., Bedford, two engines, £906; Siemens Bros. and Co., Limited, two alternators, £1,530; Johnson and Phillips, Old Charlton, three transformers, £225.

London, N.W.—The Metropolitan Asylums Board have accepted the tender of Thorpe and Waring, at the sum of £554, for wiring for electric lighting the five new wards and other buildings now in course of erection at the North-Western Hospital, according to plan and specification prepared by Prof. Ayrton, consulting engineer. The following is a list of the tenders received:

Thorpe and Waring	£554	0	0
Electrical and General Engineering Company, 86, Leadenhall-street	649	0	0
T. Matthews, Islington	650	0	0
Waring and Sons, 181, Oxford-street	688	15	0
Fowler, Lancaster, and Co., Birmingham	859	15	0
Benham and Sons, Wigmore-street	870	0	0
Paterson and Cooper, Victoria-street	895	0	0
J. Sax and Co., Ridgmount-street	944	8	9
J. C. Howell, Limited, Queen Victoria-street	981	16	4
London and Lancashire Electrical and General Engineering Company	1,050	0	0
Miller and Woods, Gray's-inn-road	1,070	0	0
Sharp and Kent, Victoria-street	1,098	0	0
Tayler Smith Electric Company, South Moulton-street	1,124	0	0
Roger Dawson, Limited, Berners-street	1,140	0	0
H. Tyler and Co., Whitecross-street	1,340	0	0
V. G. Middleton, Westminster	1,440	0	0
Vaughan and Brown, Kirby-street	1,557	0	0

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,078.

Appointment Vacant.—The Islington Vestry require an electrician at a salary of £2. 10s. per week. Particulars will be found in our advertisement columns.

Cuba Submarine Telegraph Company.—The directors have resolved to recommend the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 21st inst. amounted to £1,226, as compared with £1,034 in the corresponding week of last year, being an increase of £192.

Rotherhithe.—The Vestry have decided to offer no objection to the application of the Capital and Counties Electricity Supply Company for a provisional order to authorise the company to supply electricity in the parish.

Ceylon.—Should Mr. Mathews's scheme in connection with the Colombo electric tramways scheme fall through, it is reported, says *Indian Engineering*, that Messrs. Bounstead and Co. are ready to put forward another scheme.

Lightning Conductors.—We have received from Mr. J. S. Morris, Wardrobe-chambers, 146A, Queen Victoria-street, E.C., an illustrated circular descriptive of his copper-band lightning conductors and his special holdfasts.

Purchase.—The Nalder and Harrison Construction Syndicate, Limited, inform us that they have purchased the stock, plant, and goodwill of the engineering business carried on by Messrs. John Brown and Co. at Perseverance Works, Bow, E.

Bedford.—A meeting of the Town Council has been held at which, on the recommendation of the Electric Light Committee, tenders were accepted for supplying extra engines and electrical apparatus for the extension of the electricity works.

Fenton Bros., Limited.—This Company has been registered, with a capital of £20,000, to acquire the business of Fenton Bros., of Sheffield, Yorkshire, and 22, Bartlett's-buildings, Holborn, manufacturers of silver and electro-plated goods, etc.

Aberdeen.—Last week, through the kindness of Prof. A. B. W. Kennedy, the Corporation's consulting electrical engineer, who defrayed the necessary expenses, the employés of the electrical department of the Aberdeen Corporation had a most enjoyable picnic.

Westminster Electric Supply Corporation, Limited.—The Board have declared an interim dividend for the half-year ending June 30, 1895, at the rate of 5 per cent. per annum, payable on September 1 next to shareholders whose names were on the register on July 24.

Plumstead.—The Vestry have received notices from the Woolwich District Electric Light Company and the Capital and Counties Electricity Supply Company of their intention, severally, to apply to the Board of Trade for a provisional order to supply electricity in Plumstead.

Indian Telegraphy.—The Director-General of Telegraphs in India is in communication with the Government, says *Indian Engineering*, regarding the introduction of Waltair's magnetic induction budget for testing lightning conductors, in the place of the Backnell balance at present in use.

Bournemouth.—The Winter Gardens Committee of the Town Council have reported that they have considered the question of the lighting in the pavilion, and recommended that the surveyor be instructed to report as to any desirable alteration in the lighting arrangements. The report was adopted.

City and South London Railway.—The returns for the week ending July 21 were £831, compared with £839 for the corresponding period of 1894, being a decrease of £8. The total receipts for the half-year 1895 are £2,594, as compared with £2,600 for the corresponding period of 1894, being a decrease of £6.

The Burma Connection Telegraphs.—Work on the Burma-Kentung telegraph line will be proceeded with during the current hot weather, the necessary wire being now sent forward. Unfortunately, says the *Indian Engineer*, the rains begin early in the region to be crossed, but the staff engaged in construction will

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not be checked in their labours by anything short of wholesale sickness.

Acton.—At the District Council's last meeting it was recommended by the Works Committee that the clerk should write to the Capital and Counties Electricity Supply Company and Limbrey and Co., informing them that the Council intended to oppose their applications to the Board of Trade for a provisional order for lighting the district by electricity. The Council adopted the committee's recommendation.

Agency.—We are informed that Messrs. Francis and Spilsbury, electrical suppliers and agents, of 20, Bucklersbury, E.C., have been appointed special agents for the sale of Messrs. Connolly Bros.' manufactures in the South, East, and West of England (not including London). Messrs. Connolly Bros. are finding an increasing demand for their "Blackley" tape, and also for their specialities in vulcanised rubber-covered wires and cables.

Edinburgh.—At Tuesday's meeting of the Town Council, the Cleaning and Lighting Committee recommended that George-street and streets leading thereto from Princes-street, along with St. Andrew-street, St. Andrew-square, Charlotte-square, and Hope-street, should be lighted with electric light. It was stated that it would cost £600 more than the present gas lighting. On a division, the recommendation was adopted by 12 votes to 9.

Electric Railways for Vienna.—The Secretary of State for Foreign Affairs has received a copy and translation of a notice issued by the Municipality of Vienna calling for tenders for plans, construction, and working of a network of electric railways in and round that city. The tenders must be sent in before the 14th November next. The notice may be seen at the Commercial Department of the Foreign Office, S.W., between the hours of 11 and 6.

The Hermite Process in India.—The Bombay Corporation have considered a memorandum from the Commissioners forwarding a letter from the executive engineer on the question of the use of electrolysed sea-water for flushing sewers, etc., together with an estimate of 60,000 rupees, framed by Mr. Murzban, of the probable cost of providing and fitting up at the Carnac Bunder nightsoil station plant capable of producing 15,840 gallons of Hermite fluid in 12 hours.

Shooter's Hill.—The Ambulance Committee of the Metropolitan Asylums Board reported at the last meeting that as they considered it desirable that the Brook Ambulance Station should be lighted with electricity from the installation of the Brook Hospital, the consumption being checked and apportioned by meter, they had instructed Prof. Kennedy to prepare a scheme and specification for the purpose, which they would submit to the Board in due course.

Ootacamund.—The scheme of the Oriental Electric Light Company, Bangalore, for lighting Ootacamund with the electric light on the maintenance electric supply system by storage power, has met with great success. The whole of the Government House, including the military secretary's and the private secretary's bungalows, are to be lighted by incandescent electric lamps, also the Government House and the Banqueting Hall, and the Guindy Park, as well as Madras, in conjunction with the Government House at Ooty.

Douglas (Isle of Man)—A magnificent park, the latest addition to the Douglas pleasure resorts, is opened to the visiting public by the Isle of Man Tramways and Electric Power Company, Limited, and known as Howstrake Park. It is situated about two miles from Douglas. The grounds are of considerable extent, command probably one of the finest marine and landscape views in the United Kingdom from an eminence of over 400ft. above the level of the sea, and have been laid out by an expert so as to interfere as little as possible with nature.

Limerick.—A special meeting of the Town Council was held on Friday for the purpose of formally adopting an electric lighting scheme for the city. The Corporation are acting under certain compulsion in the matter. The lighting of the city by gas is altogether in the control of the Corporation, and if the members failed to adopt an electric lighting scheme, the Board of Trade had notified they would give the necessary permission to any company seeking to have the Order in Council enforced in Limerick, and such company would consequently be a competing rival with the Corporation.

London, N.W.—In connection with the wiring of buildings at the North-Western Hospital of the Metropolitan Asylums Board, referred to under "Results of Tenders," it was reported at the last meeting of the Board that Prof. Ayrton had stated that for the further work required he would be prepared to accept the following fees: for preparing specification and conditions of contract, 20 guineas; for supervising, testing, and certifying the work, 100 guineas; and for each attendance on the committee, made by request, before the commencement or after the completion of the work, three guineas These terms were accepted.

Derby.—Colonel Walter M. Ducat, R.E., held an enquiry at the Guildhall, Derby, on Wednesday, in respect to certain loans applied for by the Corporation of Derby under the Public Health and Electric Lighting Acts. They included the borrowing of £13,000 for electric lighting purposes, £8 595 for providing a recreation ground, £1,095 for the purchase of property for street improvement, and £943 for sewerage work and other purposes. It was explained by the town clerk that the Local Government Board had already sanctioned £35,000 for electric lighting, and the additional £13,000 now asked for was really to make up the actual expenditure over and above the sum previously granted, which included the erection of additional boilers.

Copper.—Messrs Lewis Lazarus and Sons report, under Wednesday's date: Copper opened firm at a slight advance over yesterday's quotations, and remained steady until towards the close of 'Change, when on free offerings values receded 2s. 6d. per ton, or 1s. 3d. below last night's price. About 800 tons changed hands in the morning at £44. 8s. 9d. and 10s. cash; £44. 10s. and 11s. 3d. for August; £44. 15s. and £44. 16s. 3d. for three months. On 2nd 'Change business was done at 10s., 8s 9d., and 7s. 6d. cash, 11s. 3d. August dates, 16s. 3d., 15s., and 13s. 9d. three months, closing values being £44. 7s. 6d. cash, £44. 13s. 9d. three months Settlement price, £44. 10s.

Cambridge.—At the last meeting of the Town Council the Paving, Drainage, and Lighting Committee reported that, in accordance with the resolution of the Council of the 20th ultimo, they had reconsidered their report with reference to the repair of the paving round the street boxes belonging to the Cambridge Electric Supply Company, with the result that they instructed the town clerk to inform the company that the committee were of opinion the company were liable for the repair of the paving in question, and that the Corporation could not, therefore, undertake to relieve them from their responsibility. The committee now asked the Council to confirm their action in the matter. Councillor H. M. Taylor proposed that the action of the committee be approved. This was seconded by Councillo W. F. Taylor, and carried.

The Ceylon Telephones.—It seems, says the *Times of Ceylon*, that there is very little doubt that by the commencement of the new year, the telephone system in Colombo will be in the hands of the Government. Whether that will be brought about by the existing private system being taken over by the Government or not is not settled. The alternatives seem to be these: If the various telephone companies working in the East can influence the Secretary of State so as to get the Eastern Colonies and India to take over the existing systems, that will be done in Ceylon; but should this action on the part of the Secretary of State not be brought about, then the local Government will resort to local measures and in the case of Ceylon they will establish for themselves a new exchange with a more modern system of telephoning than that which Colombo has at present.

Brighton.—At the Town Council's last meeting the Lighting Committee reported that in response to the advertisement for the supply and erection of steam and feed piping, feed pumps, economiser, water purifier, tanks, coal-elevator, and sundries required at the electricity generating station, they had received only one tender—viz, from Messrs. John Fraser and Son, of Millwall Boiler Works, who offered to do the work for the sum of £3,220, and they recommended that this offer should be accepted. Councillor Stafford proposed the adoption of this recommendation. He observed that the committee were not at present prepared to recommend the acceptance of a tender for the supply of the condensers air-pumps, air-pipes, etc. There was so much detail that they had not been able to get the matter ready. The committee were, however, anxious to prepare for the work, and they hoped to have the confidence of the Council in what they now proposed to do. The report was agreed to.

Embezzlement.—On Saturday at Bow-street, Wm. D. Boddy, 38, of Shirland-road, Maida-hill, was charged before Mr. Lushington with embezzlement. Mr. Harry Wilson (Wilson and Wallis), who prosecuted, stated that the prisoner was a cashier in the employment of the Charing Cross and Strand Electricity Supply Corporation. On June 14 Mr. Robbins, steward to the Duchess of Marlborough, paid to Mr. Thomas, a clerk in the employ of the same corporation, £26. 19s 3d. This money was handed to the prisoner, but he neglected to enter it into his books or to pay it into the bank. The matter came to the knowledge of Mr. Seal, the secretary. He questioned the prisoner, who made several false statements. A meeting of the directors was subsequently held, and the prisoner admitted having received two other sums for which he had not accounted. He called upon Mr. Seal on Friday night and volunteered to accompany him to the police station. Evidence in support of this statement having been given, Mr. Wilson said the prosecutors did not wish to press the charge. Prisoner pleaded guilty. Mr. Lushington said that it was a very bad case, and sentenced him to four months' hard labour.

Globe Telegraph and Trust Company.—The report of the directors of this Company for the year ended July 18 states that the net revenue of the Company, after deduction of expenses, amounts to £179 465, and makes, with the balance of £527 brought forward, a total of £179,992. From this amount there has been distributed the sum of £123,361 in interim dividends, leaving an available balance of £56,661. The directors recommend the payment of a final dividend for the year of 3s. per share on the preference shares and of 3s. 3d. per share on the ordinary shares, making, with the previous distributions, a total dividend for the year of 6 per cent., less income tax, upon the preference and 4½ per cent. net (against 4½ per cent. for the preceding year) upon the ordinary shares and carrying forward a balance of £1,238. Since the last meeting a further sum of £38,592, resulting from the paying off of the Direct Spanish Telegraph Company's 6 per cent. debentures has been invested as follows: 520 ordinary shares in the Direct Spanish Telegraph Company, 102 certificates in the Submarine Cables Trust, 1,135 shares in the Western Union Telegraph Company, 400 shares in the Cuba Submarine Telegraph Company. The remainder will be invested in suitable securities.

London Fire Alarms.—The Fire Brigade Committee of the London County Council on Tuesday reported that of the eight fire-alarms in connection with the New Cross fire-engine station, the

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provision of which was authorised by the Council on July 24, 1894, seven had been fixed, but as the Post Office had been unable to obtain the necessary wayleaves for the remaining one proposed to be fixed in Pepys-road, the committee had arranged that it should be fixed at the junction of St. Peter's-road with Brockley-road. The result will be that the annual charge for the eight fire-alarms would be increased by £3. 10s. The committee have sanctioned the fixing of telephone apparatus to the fire-alarm in Marshalsea-road, Southwark, where a fireman is stationed at night with a fire-escape. This will enable the fireman to receive from the engine station in Southwark Bridge-road an order by telephone to answer any call received at the station from another fire-alarm near which there is no fire-escape. It is expected that this arrangement will enable fire-escapes to arrive at fires more rapidly than is now sometimes the case, and the committee hope to be able after the recess to report what would be the cost of adding telephone apparatus to fire-alarms at other escape stations. The annual charge for the apparatus in the case referred to will be £3. 10s.

The Embankment.—On Tuesday the Highways Committee of the London County Council recommended that they should be authorised to take all necessary measures for establishing, at a cost not exceeding £16.590, electric lighting for the Victoria-embankment and the Waterloo and Westminster Bridges (but exclusive of the embankment gardens) authorised by the Council's (General Powers) Act, 1893; and that for this purpose the committee be authorised to obtain tenders and to enter into contracts on behalf of the Council. The full terms were given in our issue of 12th inst. The following amendments were moved: By Mr. Thornton (seconded by the Earl of Onslow): "That the Highways Committee be instructed to obtain reports from the engineer and the chemist upon the question whether the lighting of the Victoria-embankment and the bridges could be improved by the substitution of incandescent burners for those at present in use." By Mr. E. White: "That the recommendation be referred back to the committee with instructions to ascertain and report what is the cost of the present lighting, what would be the cost of incandescent gas lighting, and what would be the cost of electricity supplied by a company." By Mr. Benn: "That the recommendation be referred back to enable the committee to bring up a report as to the cost of including in the estimate the lighting of the Victoria-embankment gardens." The whole of the amendments were agreed to.

Anglo-American Telegraph Company.—The report of the directors for the half-year ended June 30 last states that the total receipts, including the balance of £485 brought forward from the last account, amounted to £141,715. This sum, however, is subject to revision, as the financial result of the judgment given in favour of this company against the Paris and New York Telegraph Company cannot yet be determined. The traffic receipts show an increase of £9,382 as compared with the corresponding period of last year. The total expenses of the half-year, including the repair of cables, etc., as shown by the revenue account, amounted to £55,384, being a decrease of £332. The directors, under the powers conferred upon them by the articles of association, have, before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £74,331. One quarterly interim dividend of 10s. per cent. on the ordinary stock and of £1 per cent. on the preferred stock was paid on May 1, 1895, absorbing £35,000, and a second quarterly dividend of 11s. per cent. on the ordinary stock and £1. 2s. per cent. on the preferred stock, amounting to £38,500, will be paid on August 1, 1895, leaving a balance of £831 to be carried forward to the next account. The company's repairing s.s. "Minia" has been employed during the past half-year in the repair of the 1874 cable, broken off the coast of Ireland, and of two of the cables connecting Newfoundland with Cape Breton.

Direct United States Cable Company.—The report of the directors for the six months ended June 30 states that the half-year's revenue, after deducting out-payments, amounted to £37,653, as compared with £34 843 for the corresponding period of 1894, being a difference of £2 809 in favour of the half-year under review. The working and other expenses for the same period, including income tax, but exclusive of cost of repairs of cables, amounted to £18,909, leaving a balance of £18,744 as the net profit of the half-year, making, with £1,807 brought forward from the previous half-year, a total of £20,552. For the corresponding period of 1894 the working expenses and other payments amounted to £18,750. Three quarterly interim dividends, amounting to £18.213, have been declared and paid during the financial year, and a final payment of 2s. per share is now proposed, making, with the three interim dividends, 2 per cent. for the year, being a total distribution of £24,284. After transferring £7,000 to the reserve fund account, the balance of £1,410 on the revenue account is proposed to be carried forward. During the period under review repairs of the Company's cables have cost £1,730. This amount, together with the £673 written off the buildings account, Ballinskelligs, in respect of old buildings pulled down, have been debited to the reserve fund account, the balance of which, with the addition of interest, profit, and amount transferred from revenue account, now stands at £298,369.

The Electric Lighting of Calcutta.—The following is the statement of objects and reasons appended to the Bill to facilitate and regulate the supply of electricity for lighting and other purposes in Calcutta: The Government has at present no power to grant a license or provisional order for the supply of electricity. The Indian Telegraph Act, 1885, under which licenses have been granted to telephone companies, deals only with appliances for making communications by means of electricity. Act No. XIII. of 1887 is an Act to provide for the protection of person and property from the risks incident to the supply and use of electricity, but it does not provide for the grant of licenses. Nor does it provide for many other matters which are essential for the protection of contractors from undue interference or restraint, and the public from excessive charges and undue preference. These matters cannot be satisfactorily arranged without legislation. The object of the present Bill is to enable the Government of Bengal to grant licenses for the supply of electric lighting within any part of Calcutta The Bill closely follows the Electric Act of 1882 (44 and 45 Vict., chap. 56), but as it is intended to empower the local Government to grant licenses only, every reference to "provisional orders" and "special Acts" has been omitted. The local Government is substituted for the Board of Trade throughout. The definition of Calcutta is taken from the Calcutta Municipal Act of 1884, but power is given in the Bill for extending its provisions to the Howrah Municipality. The necessary powers for breaking up streets, etc., for the purpose of supplying electricity within the area specified in the license have been adopted for the most part from the Gasworks Clauses Act of 1871.

Ipswich.—At the last meeting of the Paving and Lighting Committee of the Town Council, Mr. E. A. Paris, of the County of London and Brush Provincial Electric Lighting Company, Limited, attended and stated that his company had made an application for a provisional order for supplying electricity in Ipswich and asked the consent of the Corporation. In most towns the corporation had taken up the supply of electricity on their own account, but in others they had given their consent to the grant of a provisional order to a company under certain conditions. The company he represented were willing to accept a reasonable condition as to power on the part of the Council to purchase at any time during the 42 years, or, as they would prefer, to take an order pure and simple. The Act of 1888 gave a corporation power at any time to start electrical works, notwithstanding that they might have given consent to a provisional order being granted to a company, and that was the strongest lever there could be against any undue price being asked by the company if the corporation were willing to buy the undertaking. On the other hand, some councils felt it desirable to have a definite agreement as to the terms on which they might purchase at any time. What was known as the Oxford clause had been regarded as fair; under it the corporation would be entitled to purchase on terms of capitalising the actual outlay of the company at 5 per cent. Mr Josselyn asked whether the company was not a branch of the Brush Company, which had obtained an order and had failed to carry out the undertaking. Mr. Paris said the Brush Company was a manufacturing company, and had not capital sufficient to undertake the supply of electricity. The present company was formed for the purpose of supplying electricity, and had orders for Dover, Bournemouth, Wandsworth, St. Luke's, Camberwell; St. Olave's, Southwark; and Richmond. They had a capital of £200,000 or £300,000. Conversation followed among the members of the committee on the point whether the Electric Light Committee of the Corporation was still in existence as a standing committee, or whether, after the report presented at a recent meeting, it was not *functus officio*. It was clear that the Paving and Lighting Committee had no authority in the matter, and the Chairman recommended Mr. Paris to make a formal application for the consent of the Council, before whom it would come in the regular way.

Halifax.—Mr. F. H. Tulloch, M.I C.E., an inspector under the Local Government Board, has held an enquiry at the Town Hall, Halifax, with respect to an application made by the Halifax Town Council for sanction to borrow £10,000 for electric lighting purposes. Amongst those present were the Mayor (Alderman M. Booth), Alderman S T. Midgley, Alderman J. Brook, the town clerk (Mr. K. Walton) and other members of the Town Council. The Town Clerk said that in 1892 the Corporation obtained a provisional order empowering them to erect works for the supply of electricity. They obtained the permission of the Local Government Board to borrow £30,000 for that purpose. They had, since, however, found that they would require an additional £4,947 to complete the original scheme, and £5,000 for the purpose of extensions. They had actually expended £34,947, whereas the original estimate was only £26,100. In the original estimates the Corporation proposed to utilise some land that belonged to them, but after further consideration it was decided that a more convenient site should be obtained, which was done at a greater cost than the original estimates provided. Alderman Brook pointed out that for mains and services application was made only for £500. As the committee had now decided to extend their mains to Skircoat, he suggested that this figure be doubled. The Inspector agreed to this application. In reply to Alderman Tattersall, the Town Clerk said that Alderman Brook was quite in order in making his suggestion without having first consulted the Town Council. The works included still came within the £5.000 the Corporation had authorised him to apply for. The Inspector asked how it was that the electric light building had cost three times the original estimate. The Town Clerk said that the original plan was for the conversion of buildings situate on the first site. On the new site new buildings had to be put up entirely. They had entered into a contract for a new engine, which would be required for winter, as they were unable to wait. That was the only contract entered into that would have to be met out of the money they were now applying for. Mr. Wilmshurst, engineer to the works, in reply to the Inspector, pointed out that Skircoat was not within the Corporation's compulsory area. It, however, formed the chief

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residential part of the borough. Mains had been laid throughout the compulsory area, with the exception of Lee Bridge and Dean Clough, where they had no customers. The inspector afterwards visited the electric light works.

Harrow.—Mr. Oliver A. Saunders, of Harrow, writes to a local paper as follows: "It has been pointed out to me that, although a lawyer or other man of business will readily appreciate the mischief of allowing a monopoly of the supply of electricity to be established in private hands in Harrow, yet some explanation is necessary to place the matter clearly before the ratepayers, who may otherwise imagine that the monopoly will not affect themselves, since no local company can be expected to produce electricity at such a price as will bring it within their reach. The ratepayers last year wisely refused to accept the late Board's scheme, which involved the production of 43,000 units of electricity for street-lighting, at the nominal charge of about 3d. per unit, instead of 8d., thereby imposing a dead loss of over £900 a year on the town, as producers, under that item alone. It suits the purpose of those who are now seeking to obtain a monopoly to represent that this refusal justifies them in saying that the provisional order is useless to the town, and may be properly handed over to a company, if the ratepayers are relieved of the cost of obtaining it, a cost which is represented by a temporary annual charge of about £20 a year. The concession, it is true, probably has little direct value in itself, but its indirect value to an electric lighting company would consist in the power which they hope to acquire thereby of excluding competition, and thus maintaining the price of electricity at the high level at which alone a local company can afford to produce it. When the time comes (and it is surely not far off) that electricity can be brought from the coalfields to our doors at a price which will bring it within the reach of every ratepayer, then the ratepayers would fully realise the mistake of allowing the town to be saddled with a monopoly for the benefit of a small section of the community. To create such a monopoly is, in fact, merely another method of throwing upon the ratepayers a part of the very same risk which they emphatically repudiated last December, since it would impose a prospective tax upon cheap electricity in order to secure a return upon capital which is to be expended exclusively for the benefit of a few individuals. If cheap electricity does not come the monopoly will be useless, if it does come the monopoly will impose an unfair burthen on the poorer ratepayers; in neither case can the creation of such a monopoly be justified. The provisional order has been obtained at the expense and for the benefit of the whole community, and is available by way of license for the use of any ratepayers who wish to supply themselves or their neighbours with the electric light, but the Electric Lighting Act of 1888 clearly provides that no monopoly shall be created by the grant of a provisional order without the consent of the local authority; and it is a manifest betrayal of trust for a local authority to attempt to deprive the poorer inhabitants of this protection by appropriating the benefit of the provisional order for a few wealthy ratepayers, to whom the cost of electricity is a secondary consideration. Happily, we now have an opportunity of applying to the Board of Trade to protect us against this injustice. A copy of the memorial awaits signature at Mr. Provost's shop, and further copies can be there obtained by any ratepayer who is willing to assist in obtaining other signatures Such assistance is urgently needed."

PROVISIONAL PATENTS, 1895.

JULY 15.

13550. **Improvements in dynamo-electric machinery.** Frederick Henry Royce and Ernest Alexander Claremont, Electron, Cavendish-road, Chorlton-cum-Hardy. (Complete specification.)

13564. **Improvements in and relating to electric regulators.** William Vernon Bonsor, 126, Gladstone-road, Wimbledon, London. (Complete specification.)

13573. **Improvements in multiple switches for telephone exchanges.** Franz Stock, 46, Lincoln's-inn-fields, London. (Complete specification.)

JULY 16.

13618. **Improvements in or relating to electrically-actuated mechanism.** Septimus Felix Beevor, 433, Strand, London.

13619. **Improvements in and connected with underground conductors for electric railways and tramways.** Jasper Wetter, 433, Strand, London.

13635. **Improvements in electric gaslighters.** Harry Graham Grier, Albert Gleaves Grier, and Alfred Samuel Hottle, 47, Lincoln's-inn-fields, London. (Complete specification.)

13636. **Improvements in electric signalling apparatus.** Lucien Stephen Crandall. 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 17.

13663. **Improvements in connecting plugs and switches for electric lighting and power purposes.** Julius Peschek, 8, Great Portland-street, London.

13670. **Improvements in and connected with electrical incandescent lamps.** Henry Cooper, 70, Market-street, Manchester.

13689. **Improvements in the manufacture of incandescent electric lamps.** Alfred Vincent Newton, 6, Bream's-buildings, Chancery-lane, London. (Alfred Nobel, France.)

13695. **Improvements in portable electrical railway carriage and other roof lamps.** Henry William Headland, 77, Chancery-lane, London.

13702. **Apparatus for regulating or measuring electric currents.** Henri Pieper (fils), 31, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JULY 18.

13727. **Improvements in or relating to combined alternators and dynamos and the like, and to the distribution of electricity thereby.** John Augustine Kingdon, 29, Marlborough-hill, St. John's Wood, London.

13730. **Improvements in and relating to primary batteries.** Walter Rowbotham and Hymen Levetus, 45, Southampton buildings, Chancery-lane, London.

13760. **Improvements in and in connection with the working of electric tramways on the accumulator system.** Charles Rayleigh, 191, Fleet-street, London.

JULY 20.

13872. **Improvements in or connected with steam alternators and the like and in the mode of operating them for the distribution of electricity.** John Augustine Kingdon, 29, Marlborough-hill, St. John's Wood, London.

13900 **Improvements in galvanic batteries.** Ralph Wardlaw Gordon, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Section 103, January 31, 1895, being date of application in United States.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1894.

15353. **Electric motors.** Routledge.

15737. **Phonographs.** Edison-Bell Phonograph Corporation, Limited, and Wilkinson.

16131. **Electric signs, etc.** Hawksey and Lamb.

16331. **Electric organs.** Harrison.

1895.

1797. **Electric lamps.** Stiens.

8393. **Electric lighting of railway vehicles.** Moskowitz and others.

8394. **Dynamos.** Moskowitz and others.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¼-5⅜
Brush Company, Ordinary	3	2⅞-2⅞
—— Nom. Cum., 6 per cent. Pref.	2	2⅞-2⅞
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5¼-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	16-17
—— 5 per cent. Debenture Stock	100	131-134
City and South London Railway, Consolidated Ordinary	100	42-44
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14½-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A 1-200 of £50	100	—
Electric Construction, Limited	2	¾-1
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	2-2½
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	¾-1⅛
Elmore's Wire Company	2	1-1½
Fowler-Waring Cables	5	⅛-¼
W. T. Henley's Telegraph Works, Ordinary	10	10½-11½
—— 7 per cent. Preference	10	14-15
—— 4½ per cent. Debentures	100	104-107
House-to-House Company, Ordinary	5	3¾-4
—— 7 per cent. Preference	5	7⅛-7½
India Rubber and Gutta Percha Works	10	19-21
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅜-7¾
—— Pref.	—	—
Liverpool Overhead Railway	10	10⅝-10⅞
—— Pref.	10	14¾-15½
—— 4 per cent. Mortgage Debentures of £100	100	110-112
London Electric	5	¼-½
Metropolitan Electric Supply	10	10½-11
—— 4½ per cent. First Mortgage Debenture Stock	100	116-119
National Telephone, Ordinary	5	5⅞-6⅛
—— 6 per cent. Cum. First Pref.	10	16-17
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-6¼
—— 3½ per cent. Deb. Stock	100	105-107
Notting Hill Company	10	8¼-8¾
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	5	7-7½
—— £4½ shares	4½	5¾-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8-8¼
—— 7 per cent. Pref.	5	9-9½
Swan United Ordinary	3	2-2½
—— 4½ per cent. Debentures	100	104-107
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4⅜-4⅝
Westminster Electric Supply, Ordinary	5	7⅞-8¼
Yorkshire House-to-House	5	5¼-5⅜

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NOTES.

Cable Communication with Caldy Island.—The telegraph ship "Monarch" was in Tenby Roadstead on Monday awaiting a favourable opportunity to lay a cable connecting Caldy Island with the mainland.

Personal.—King Alexander of Servia has conferred upon Prof. H. J. Spooner, the director of the Polytechnic School of Engineering, a Knight Commandership of the Royal Order of St. Sava, as a recognition of Mr. Spooner's labours in the cause of science.

Electricity in the Navy.—H.M.S. "Powerful," which has been launched from the yard of the Naval Construction and Armaments Company, Barrow, is lighted throughout with electricity, having about 900 incandescent lamps and six powerful search-lights.

Books Received.—We are in receipt of the *English Illustrated Magazine* for August, which contains a good variety both of literary matter and of illustrations.—Messrs. Crosby Lockwood and Son send us "The Management of Dynamos," by Mr. G. W. Lummis-Paterson.

Post Office Telegraphs.—Mr. Chas. E. Stuart, controller of stores, General Post Office, writes: "I beg to inform you that the offices of the Controller of Stores (Postal Telegraphs), hitherto situated in Telegraph-street, have been removed to the General Post Office, St. Martin's-le-Grand."

Electric Traction in Spain. — The municipal authorities of Barcelona are actively arranging for the introduction of electric traction into their city. They have appointed a commission of 30 members to examine and report upon the systems adopted in Marseilles, Genoa, and Milan.

The Electric Light in Spain.—*El Imparcial* reports the inauguration of the electric light in another Peninsular town, Orense, which, situated in Galicia, and the capital of the province of Orense, has a population of 15,000. There were great celebrations in honour of the introduction of the popular illuminant.

Electricity in Russia.—The Russian naval authorities have appointed an electrical engineer for the port of Cronstadt, who will take the rank of a staff officer and receive a salary of 3,200 roubles, or £500, a year, and whose first duty will be to organise a system of electric deck-lighting for the Tsar's Baltic fleet. It is stated that a similar post already exists at Nikolaiev.

Welsh Jocosity. — The following paragraph has appeared in the *South Wales Daily Post*: "One of the reasons given for delay in introducing electric lighting into Swansea is the great distance between the poles which support the lamps, the present arrangement of lamp-posts being found very convenient by gentlemen returning home after a 'smoker' or banquet."

Purification of Acetic Acid by Electricity.—Crude acetic acid is usually purified by distillation in copper vessels, a resulting by-product, acetate of copper, being very noxious, especially in the dyeing industry, when alizarine red is being produced. A M. Eremin has, it is stated, invented a process of electrical refining which is giving great satisfaction in Russia.

Telegraphy in British North Borneo.—A telegram has been received from the Governor of British North Borneo to the effect that 90 miles of the telegraph across the country have been completed and are open for communication with the coast, and it is expected that, if not unduly hindered by the rainy season, the line will be finished for through communication to Sandakan by January next.

Lighthouse Communication.—The Central News says that a deep-sea cable, connecting the mainland near Browhead to the Fastnet Rock Lighthouse, has just been completed for the Board of Trade. The purpose of the cable is not only to signal and report all passing vessels, but to give them their orders at sea. The scheme is looked upon as one of considerable importance to shipowners and mariners.

The Galatz Tramways.—With reference to the paragraph headed "Corruption?" in our issue of July 12, page 29, the French Consular Department officially announces that the contract for the construction of the electric tramway in Galatz has been let to the Société Charles Georgi, of Paris, which company is already the concessionnee of the gas and electric lighting of that Roumanian town.

"Electrocution" of Dogs.—Hereafter all stray dogs caught in Brantford, Ont., will be electrocuted. The victim is fitted with four leather boots with metallic soles; a piece of wet sponge is fitted in the interior of the boot, and a copper wire connected with the street-lighting system is attached to the metallic soles. A policeman holds the dog by a rope around the neck, and a fireman acts as executioner. A switch in the fire-hall is turned on, giving a current of 1,700 volts.

Junior Engineering Society.—We have received the *Transactions* of this society (now called the Institution of Junior Engineers) for the thirteenth session, 1893-4. The papers read include one by Mr. A. H. Dykes on "Electromotors," and among the works visited and described are the Cardiff electric light works, and the Great Eastern Railway Company's electric light works, London. In addition, visits were paid to the engineering laboratories of the Battersea Polytechnic and University College, London.

Japan's Import of Dynamos.—According to the latest statistics available, we have forged ahead of Germany in respect of the supply of dynamos to Japan. In 1892, the figures for the Fatherland, machines to the value of 73,741 yen, were far in advance of those which could be claimed by this country and the United States; but in 1894 the import from Germany was valued at 18,120 yen only, compared with the respective amounts of 49,322 yen for Great Britain, and 145,200 yen for North America. The yen is worth about 3s.

Electric Cranes.—The officers and engineers of the Portuguese warship "Vasco da Gama" have specially visited the Southampton Town Quay to inspect the working of the electric cranes erected there some time since. They were received by Mr. W. Bowyer, the wharfinger, and Mr. J. E. W. Aldridge, electrical engineer, and shown the cranes in operation. These two cranes are the only jib cranes of their size and construction in this country. Great interest was evinced in the matter by the officers, and they expressed their admiration at the manner in which they were manipulated with working loads.

Trans-African Telegraphy.—Slatin Pasha has been interviewed, and on being asked as to how the Trans-African telegraph scheme was likely to fare in the Sudan, said: "What is the necessity for the line? It is impossible to get a telegraph across Africa until the whole of the continent is under European, Ottoman, and Egyptian control. When this is accomplished, then it is time enough to talk of a telegraph. Mr. Rhodes's scheme, as far as the Sudan is concerned, is an impossibility until the Dervishes are wiped out. To make arrangements with or subsidise them is quite out of the question."

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Electric Headlight for Cyclists.—An electric headlight for cyclists has been invented by an American firm. A small storage battery of about eight ampere-hours' capacity is carried on the bicycle or in the rider's pocket, and a body wire leads from it to the terminal points on the back of the cap. The lamp in front is detachable and weighs only about 1½oz. In this simple manner a true searchlight is obtained, because the light is always focussed in the same direction that the rider looks, and being on the visor of the cap the eyes are protected from the light, which illuminates the way most satisfactorily.

Gas and Electricity.—The *Semaine Electrique* remarks that it has often defended the cause of the union of gas and electricity. After Ostend, it says, we have Galatz, Braila, Szegedin, Alba, and Arad, in which the companies who have obtained the necessary concessions have engaged to supply both illuminants and produce their electricity by means of gas-engines. Moreover, in some of the towns enumerated the motive power of the tramways will be generated under the same conditions. Our contemporary adds that the shareholders of the Société Internationale de Gaz ou d'Electricité, at the head of which is M. Somzée, will not regret embarking in an enterprise which cannot but prove a source of considerable profit to them.

Telephone Charges in France.—French papers grumble that the subscription to the telephone in France still costs 400f. a year, especially, they argue, in view of the comparatively inefficient service which is provided by the State. Reference is made to the charge of 150f., plus a franc for interurban communication, current in Belgium, and to the rate of 40f., "everything included," in Switzerland. The papers suggest that the Government should apply the same principle to telephonic communication that it has used in the postal service—namely, effect a reduction in the charges—and thus secure a considerably extended personal subscription. We have the same complaint in England, but we adopt the still more unfavourable comparison of Sweden.

Trolley Parties in Philadelphia.—Trolley cars are being largely used in the United States for pleasure parties who hire special cars and go for long runs into the country. In an article on the subject of this method of amusement in Philadelphia, a New York paper states that "such parties have become a fashionable craze among 'stay-at-homes' and 'can't-get-aways,' and people of the most respectable caste join in the popular movement. The popularity of trolley locomotion and mid-summer night sociables on wheels forms a remarkable contrast to the warlike opposition that was waged against the introduction of overhead wire transit in Philadelphia. When it came it met with a wail of opposition. Now, if it should be taken away from us the bottom would fall clean out of the old City of Brotherly Love, and it would fairly collapse."

Electric Motors in Gasworks.—At the meeting of the Institution of Mechanical Engineers in Glasgow on Tuesday, Mr. Andrew S. Biggart, of Glasgow, read a paper on "Hydraulic Stoking Machinery and Labour-saving Appliances in Modern Gasworks." In the course of the discussion that followed, Mr. Head said that the ingenuity displayed in the charging and discharging retorts had been very much the result of the labour troubles of some two or three years ago. He would like to know whether Mr. Biggart had turned his attention to the substitution of electric means for hydraulic power in this kind of machinery? It seemed to him that this bore a resemblance to an overhead travelling crane, and in America electricity had very much taken the place of other mechanical appliances. Mr. Biggart, in reply, said that with regard to the electric power, that was a matter which had received attention, but the objection to such power was this, that they would require to introduce revolving machinery and shafts.

Effect of Volcanic Action upon Earth Currents. Signor L. Palmieri, of the Vesuvius Observatory, has taken observations during the past six years upon the action of earth currents on a telegraph line extending between the observatory and Resina. He has found that when Vesuvius is inactive, or during periods of minimum activity, the earth currents flow upward, irrespective of the azimuth at which the wire is placed, increasing and diminishing inversely as the activity of the volcano. When this activity reaches a certain point the currents cease, and if the volcanic action still further increases the earth currents begin flowing downwards, increasing with the activity of the crater. The experimenter, therefore, concludes that in the case of wires inclined to the horizon and out of the reach of volcanic interference the earth currents flow upward in whatever azimuth the wires are placed.

The Lyons Electrical Power Project. — The Société Lyonnaise des Forces Motrices du Rhône, a correspondent says, recently opened a competition with the view of obtaining the best project for utilising, at the Canal du Jonage, the water power of the Rhone to the extent of 20,000 h.p., with the object of supplying the city of Lyons with electrical energy for lighting and industrial purposes. The jury which was called upon to deliver its judgment upon the various plans selected, and which consisted of Prof. Galileo Ferraris, of Turin, and MM. Eric Gérard and R. V. Picou, has now awarded the first prize of 10,000f. to the joint project of the Compagnie de l'Industrie Electrique, of Geneva and Paris, and Messrs. Escher, Wyss, and Co., of Zürich, the former firm being responsible for the electrical portion of the scheme and the latter firm for the hydraulic part. The second premium of 5,000f. was obtained by Le Creusot; the third, of 3,000f., by the Société Alsacienne; and the fourth, of 2,000f., by L'Electro Mécanique.

The Telephone Service.—We have already given the report of the Select Committee of the House of Commons on the telephone service. This report, together with the minutes of evidence, is now issued as a bulky Blue-book of 370 pages, which can be purchased by those who require it. However, the proceedings of the committee were duly recorded, though not at such inordinate length, in the columns of the *Electrical Engineer* at the time. The committee, we may remind our readers, comprised the following: Captain Bagot, Mr. Baird, Mr. Benn, Sir Charles Cameron, Mr. John Ellis, Sir James Fergusson, Sir Julian Goldsmid, Sir John Gorst, Mr. Grant Lawson, the Solicitor-General, Mr. Arnold Morley (chairman), Mr. Moulton, Mr. Snape, Lord Stanley, and Mr. Tully. If another committee be appointed, as the old committee recommend, many of these gentlemen will perforce be absent from it, owing to their having been "chucked" by their constituencies, for with respect to a party which once existed one must ask with Hans Breitmann, "Vare is dat bardy now?"

The Renault Dry Cell.—The *Bulletin International de l'Electricité* of July 22 contains an account of the "elegant and very practical" dry cell invented by Prof. Renault: "It is composed of a vessel of agglomerated retort carbon, in the bottom of which is chromic acid combined with gelatinous silex, which possesses the remarkable property of absorbing 60 times its volume of water. This composition constitutes the active part of the cell. This portion is insulated from the

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rest of the apparatus by a porous earthenware disc, supporting a spiral of zinc containing in its volutions gelatinous silex only. The method of operating will easily be understood. The chromic acid acts upon the zinc in passing across the porcelain disc and produces the current. The advantages of this cell lie in the considerable surface development of the carbon of which the vessel is composed and of the helical zinc, thus giving a maximum of surface with a minimum of encumbrance. This apparatus, then," the journal adds, "is capable of furnishing considerable energy from a small volume."

Electric Fountains.—The electric fountain at the Cotton States and International Exposition, which has been devised by Mr. Luther Stieringer, the consulting electrical engineer to the exhibition authorities, is attracting much attention in America. The design is that of a twin fountain, rising from an islet in the centre of the great basin, immediately in front of the machinery hall. The island, which forms the groundwork for the base of the fountain, and covers the operating-chamber, is 100ft. long and 50ft. wide. There are 19 orifices, each with from seven to ten jets. The electric lights used under each opening to project the beam of light through the water are of 250,000 c.p. each. The four forms of water used are the solid stream, the geyser, the spray, and the fog-bank. The highest jets will rise over 100ft. from the basin of the lake. The fog-bank is to be produced by steam, condensed by means of spray. The four forms will be used alternately in various ways. The streams and geysers will be interspersed with circular pipes throwing jets in the form of wheat sheaves.

The Disturbance of Electrical Instruments.—In view of the objection which has been raised by the authorities of the Imperial Physical Institution in Charlottenburg, the favourite suburb of Berlin, against the introduction of electric traction on the local tramway lines, it is interesting to note the fate of the complaint which was made by the Senate of the University of Halle-a.-d.-Saale anent the proposed construction of an electric tramway along Ulrichstrasse, in that city, on the ground that the accurate working of the instruments in the physical department of the university would be interfered with. The Minister of Public Works has decided that the objection cannot be maintained, and, furthermore, that consideration cannot be given to the claim of the University Senate that the concession of the proprietors of another electrical line, which has been in operation for some time, be withdrawn, owing to alleged defects in the system of returning the current through the rails. It is said that the opinion of Prof. Slavi, of Königsberg, considerably influenced the decision of the Government official.

The Vibration Question in Germany.—Electrical engineers in the German capital are congratulating themselves upon the victory which the Berliner Elektrizitäts-werke has won on the vibration question. The "Viktoria" Insurance Company brought an action against its neighbour, the electrical company, to recover 362,000 marks (£18,100), being alleged damages sustained by the plaintiffs through their inability to let or sell their property on account of the noise created by the machinery of the defendants, which, it was averred, was felt to a considerable extent even in the topmost rooms of the building. The Landgericht viewed the case of the insurance company with but poor sympathy, and assessed the value of the injury sustained by it at only 25,000 marks (£1,250). Against this decision both parties appealed to the Kammergericht, with the result that the judgment of the lower Court has been quashed and the plaintiffs have been non-suited, the judges being of the opinion that the vibration complained of was not in excess of that which can be borne and which must be borne in a city like Berlin! And the Versicherungs-Aktiengesellschaft "Viktoria" is, like Lord Ullin, left lamenting.

Electric Traction in Belgium. — The Société Nationale des Chemins de Fer Vicinaux Belges has under consideration the substitution of electric traction for steam locomotives on several lines, that in the case of the Brussels and Petite-Espinette line having been made on October 1 last, since which time the 15-minutes' service has been perfectly regular. The E.M.F. necessary for working the line is furnished by the Union-Electricitäts-Gesellschaft, of Berlin, working the Thomson-Houston patent with which a contract has been made for 10 years, and which undertakes maintenance, repairs, and renewals, while assuming the whole responsibility. Wherever necessary, the trolley wire and feeders are protected by laths for preventing the contact of telegraph and telephone wires which might fall upon the line. Lightning conductors are placed at the generating station, on the line, and on the carriages, which latter are fitted with hand-brakes. In the event of accident, however, the current in the motors may be reversed, so as to effect an almost instantaneous stoppage. If, owing to an unfortunate coincidence, the hand-brake should happen to give out at the same time as the current, the train may be brought to a standstill, or allowed to descend a falling gradient, at very slow speed, by the two motors being put in parallel.

City and Guilds of London Institute. — The council of the institute have announced that the matriculation examination of the Central Technical Colleges will be held on September 17-20, and the entrance examination of the day department of the Finsbury Technical College on September 17. The new session in each college will commence on October 1. The diploma of "Associate of the City and Guilds of London Institute" has been conferred by the council of the institute upon the following matriculated students who have this year successfully completed the full course of instruction at the Central Technical College: civil and mechanical engineering—H. S. Andrewes, F. G. Arnould, J. E. Chapman, H. E. Fenwick, C. S. Hainworth, E. W. Hainworth, B. H. M. Hewett, E. W. Hummel, F. T. W. Lewis, F. E. Morgan, R. E Reeves, and H. Robinson; applied physics and electrical engineering—J. M. Barr, S. Beeton, C. Brandeis, W. M. Carver, A. D. Constable, S. Gilford, F. S. Grogan, A. C. Hanson, G. S. Hewett, C. D. Le Maistre, P. G. Phelps, W. Reilly, W. Roberts, H. G. Solomon, R. J. J. Swann, C. P. Taylor, E. L. Thorp, E. L. Webb, and N. J. Wilson; applied chemistry—W. G. Bennett, W. A. Davis, W. T. Gidden, C. Revis, E. M. Rich, and P. Spencer.

The Paris Exhibition Buildings.—The arrangements for the Paris Exhibition of 1900 are going briskly forward, and an estimate of the cost of the buildings, etc., arranged for has been received, which shows clearly the great extent of the undertaking. The total reaches $3\frac{3}{4}$ millions sterling, about double that of the last exhibition, which, it will be remembered, left a surplus. Two immense palaces are to be erected on the Champs Elysées, to cost £825,000. Then on the Esplanade des Invalides, the remaining buildings of the former exhibition are to be removed, with the exception of the immense machinery hall, and in their stead new buildings erected at a cost of just under a million. The exhibition is to extend right across the River Seine, and a broad bridge is to be erected, in addition to several footbridges, while the banks are to be levelled up, parts reclaimed, and the whole laid out as gardens, etc., at a cost of a quarter of a million.

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Fountains, special pavilions, etc., will absorb £330,000, and these will include a separate exhibition of physical exercise and aerostation at the Bois de Vincennes. As many as possible of the mechanical exhibits are to be shown in motion, and the machinery for driving exhibits and lighting, etc., is to cost about a quarter of a million. Workmen's exhibits are to be admitted free, and £28,000 is laid aside for buildings, etc., while for such other purposes as musical performances, judging, etc., large sums are estimated. The sum named includes £24,000 for putting the site into a permanently satisfactory condition after the exhibition is over.

A New Application of Electromotors is described in *Dingler's Polytechnisches Journal* of July 26. The Martin furnace at the Lauchhammer Works, near Riesa, has to be fed eight times daily with about 13 tons of iron. This has hitherto been done by hand at great expense of time and money, apart from the considerable inconvenience suffered by the men from the fierce heat to which they were exposed. With the new feeding apparatus, one man, it is stated, can do in a tenth of the time the work of the four men who have hitherto been necessary, and is not subjected to anything like the same temperature. The old iron is now loaded in the yard into iron troughs, three or four of which rest on a small truck, which is hauled by an electric motor in front of the furnace. On a second parallel line is the feeding machine proper, a good sized truck, on which there are a large electromotor and three small ones. The feed wagon runs rapidly to one of the troughs; a long gripper swings out, catches it, lifts it from the truck, runs with it to the door of the furnace, thrusts it in, causes it to drop its contents, rapidly withdraws it, and lays it empty back in its place. The mechanism appears to be very simple, each movement of the apparatus being effected by a separate electromotor. The machine was constructed by the proprietors of the Lauchhammer Works themselves from drawings made in America, the electrical arrangements being furnished by the Aktiengesellschaft Elektrizitätswerke vorm. O. L. Kummer und Co., of Dresden. In order to accustom the men to the working of the new apparatus they were practised beforehand at a mock wooden furnace.

Light Railways and Cable Ways.—A lecture on light railways, cable ways, etc., has been delivered to the members of the Balloon Society by Mr. W. J. Brewer, C.E. Mr. Ernest Benedict took the chair. The chairman in his opening remarks said he was very much impressed by the railway constructed by Mr. Brewer at the Dyke, Brighton. He thought his system of overhead cable lines had overcome at least one difficulty which had been felt with regard to light railways. The lecturer, after referring to the importance to commerce of cheap and easy transit and to the conference which had been invited by the late Government on the subject of light railways, went on to describe the suspended cable-way system which he had invented and which had been successfully at work at the Dyke. The cost for a light railway of this kind would be about £250 per mile, exclusive of cars and engine. The advantages were—first, as to cost, which, taking weight for weight, would be vastly cheaper than a surface line of the ordinary type. It would not interfere with the land, and he believed it especially met the difficulty of transport now felt in many manufacturing districts, for by it goods could be speedily conveyed and at a cheap rate from the manufacturer to the railways. Then it did not require locomotives nor level crossings, nor in any way interfered with the ordinary traffic on roads. The system, he said, was capable of enormous development. There was no reason why whole trains of railway carriages, wagons, etc., should not be taken across rivers by this means, and he also proposed to ascend mountains by zig-zag lines. As to motive power, the system was equally open to gas or electricity. Mr. Brewer added that he had perfected a cable system for surface lines where an overhead track was not considered advisable. A resolution was moved by Mr. Lefevre, the president, to the effect that a system of light railways and cable ways would prove of great value to England and its colonies. This was seconded by Mr. S. Green, and carried after discussion.

New French Electrical Legislation. — The Chamber of Deputies has promulgated a new law regarding the laying or erecting of conductors of electrical energy other than telegraphic and telephonic lines, the salient points of which are as follow: Article 1 provides that, apart from public works, electric conductors which are not intended for the transmission of signals and of speech, and to which the law of December 27, 1851, is not applicable, may be laid or erected without authorisation or declaration. Article 2 provides that overhead conductors are not to be placed within a horizontal distance of 10 metres from each side of a telegraphic or telephonic line without the consent of the postal authorities. Article 3, that the Minister of Commerce, of Industry, and of Posts and Telegraphs, on the advice of the electrical committee, shall determine the modifications to be made in the lines at present existing within the above-mentioned prescribed distance. Article 4, that no conductor shall be fixed above or below public thoroughfares without an authorisation given by the prefect on the technical advice of the engineers of the postal and telegraphic authorities and conformably to the instructions of the Minister of Commerce, etc. Article 5, that the above-mentioned decrees do not apply to the installations of conductors of electric energy made for their requirements by the State departments or by the promoters of public works subject to State control; projects of these electric installations, as well as modifications therein, to be, save where they concern railways, etc., submitted for the approval of the Minister of Commerce. Article 6, that a permanent electrical committee is to be formed by the Minister of Commerce, half the members of which will be professional representatives of French electrical industries; this committee to give its opinion upon all questions that may be referred to it by the Minister; while Article 7 enacts that every electrical installation must be worked in such a manner as not to interfere by induction, or otherwise, with pre-existing telegraphic or telephonic lines; should, however, the installation absolutely require the shifting or modification of the pre-existing lines, the electrical committee will be consulted, and the cost of such shifting or modification must be borne by the promoters of the new installation. Due penalties are provided for contravention in any way of the new law, which was promulgated on June 25, 1895, and signed by the President, (M. Faure) and by M. André Lebon (the said Minister of Commerce, etc.).

Electric Traction in Germany.—For a long time past the question of the further improvement of the means of traffic in Berlin has been a standing subject in the deliberations of the Municipal Council. At the present moment, says the Berlin correspondent of the *Times*, this question arouses more interest in view of the industrial exhibition which is to be held next year at Treptow, which is a considerable distance from the centre of the capital and but poorly supplied with means of communication. There seems, however, little doubt that a concession will be granted for an electric tramway from the city to the exhibition. The question with regard to the facilitation of traffic within Berlin itself is more complicated. The capital

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is provided with a metropolitan railway, a network of tramways, and also with omnibuses which, excellent as they confessedly are, have nevertheless not been found capable of coping with the increasing demands of the population. Aware of this, the civic authorities some time ago sent three of their members on a tour of inspection through large German and foreign towns in order to study the traffic arrangements and to compare them with those of Berlin. This task has been accomplished, and the mission has returned after visiting, among other cities, Dresden, Frankfort-on-the-Main, Strassburg, Paris, London, Liverpool, Glasgow, Edinburgh, Amsterdam, and Brussels. The verdict of the mission is that Berlin is in respect of traffic facilities, with the exception of electric tramways, as well supplied as any German or foreign town of large size, and that in many cases Berlin is far ahead. After hearing this report the committee appointed by the magistrates decided to recommend the municipal authorities to grant the funds requisite for carrying out experiments in Berlin with the most modern systems of electric tramways. Hitherto the Municipality has always contracted for the construction and administration of the tramway lines, but the committee has suggested that the authorities should now undertake the work themselves. Apart from the fact that the decision of the committee must be ratified by the Municipal Council, there are several obstacles in the way of a speedy realisation of this scheme. There still prevails, for instance, great diversity of opinion as to the comparative advantages of overhead and underground cables for conducting the electric current. The former will probably be employed for the less frequented streets and the latter for the great thoroughfares. Again, the concessions granted to existing tramway lines may prove a hindrance, as the companies, which pay large dividends, will probably be very tenacious of their rights. If, however, Berlin is to keep up its reputation as a model city in such respects, it must sooner or later introduce electric tramways.

Desecration Again.—Nelson's monument is now free, as we have previously stated, from so-called "desecration" by electric search-lights, but the Falls of Foyers now afford material for desecration discoverers. The subject was thrashed out a long time ago, but it is revived this week by the Duke of Westminster in his capacity of president of the National Trust for Places of Historic Interest and Natural Beauty. The duke writes: "Some months ago several questions in the House of Commons, and a considerable amount of comment in the Press, drew public attention to a proposal involving the destruction of the well-known Falls of Foyers on Loch Ness. As most people seem to have been left under the erroneous impression that the danger has been averted, I am desired by the National Trust to beg leave to inform your readers of the true state of the case. Workmen are at present employed at Foyers in making a tunnel from a point above the upper fall to a point below the lower fall. Through this tunnel the whole of the waters of the Foyers river will be conducted for the purpose of manufacturing aluminium by means of electricity, so that, as the agent of the Aluminium Company humorously states, 'the falls will not be injured, only there will be no water in them.' The proposed factory will not only destroy the finest waterfall in the United Kingdom, it will also emit hydrofluoric-acid gas, which will be most destructive to vegetation in the neighbourhood. In addition to this, it appears that the manufacture of aluminium will certainly create great spoil-banks, which the company are under no obligation to remove should they at any time suspend operations, nor, in the event of such a contingency arising, are they liable to restore the lakes of Stratherrick to their former levels, or to divert the water again to its original channel. Sir George Trevelyan, in reply to a question addressed to him last session in Parliament, stated that any investigation or restriction of this company's doings must be by the County Council of Inverness-shire. It is necessary to the operations of the company that certain roads should be diverted, and this cannot be done without the consent of the County Council, consequently that body commands the position. The National Trust has been given to understand that the Road Board of the County Council has reported in favour of allowing the diversions, but the Council has not yet ratified the decision of the Road Board, and has deferred all consideration of the matter until its October meeting. In the meantime Scotland will no doubt receive its annual quota of visitors, and it is very desirable that all who care for the beauties of the Highlands should join in a protest against the act of desecration which is in progress."

Electrical Conventions in Canada.—The fourteenth annual meeting of the American Street Railway Association will be held in Montreal on October 15, 1895, continuing for four days. The Victoria Rink, at the rear of the Windsor Hotel, has been secured for the exhibition of supplies and manufactures of every kind used in tramway operations. It is the intention of the promoters to make this exhibition "the most interesting of any yet seen," and a cordial invitation has been extended by the association to all manufacturers and producers of street-railway supplies to exhibit their machinery and wares. The Canadian Custom authorities have agreed to allow goods intended for the exhibition to cross the border at reduced rates. Exhibition space will be allotted on August 1, the charge for room being at the rate of 15 cents a square foot, not less than 50 square feet nor more than 1,000 square feet being rented to one exhibitor, unless by special arrangement. Electric power will be furnished to those who desire it at the rate of 45 cents per rated kilowatt of machine actually using current. The minimum charge will be 15 00dol. Mr. Stonewall Jackson, of 17, St. Sacrament-street, Montreal, is the local secretary for the meeting. It is interesting and amusing to note the comment of one New York journal, the *Electrical Age*, upon this exposition. It says: "Electricity's march is one of continual conquest, but so far it has not yet succeeded in breaking down the insulation of the frontier line between the United States and Canada. The American Street Railway Association will hold its convention this year in Montreal, but the bothersome Customs regulations confront intending exhibitors. According to the announcement of Secretary Partridge, the usual regulations will be somewhat relaxed on this occasion in order to afford the greatest facility for the entry and display of exhibits. The daily Press rant and preach about the annexation of Canada to the United States, but there the matter ends. Would it not be surprising, therefore, if the peaceful but all-conquering agent—electricity—accomplished the results so much desired by these vociferous newspapers? The National Electric Light Association held its convention in Montreal in 1891, and never was there seen in that country such a display of electrical apparatus and applications of the same; another convention, although of a different character, but essentially electric, to be held next October, will make our Canadian friends open their eyes and ask themselves why they are so near and yet so far from their great neighbour." The fact is, that many Canadians wish they were not so close to their "great neighbour." They know that it would be advantageous to them in many ways.

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SOME USES OF CURVES IN ELECTRICAL PRACTICE.

BY H. H. SIMMONS, A.I.E.E.

(Continued from page 102.)

For the sake of improving our general understanding of curves we will revert occasionally to the use of oblique axes, but not for the treatment of any practical problem.

What line, for instance, is the line $x = y$, when the equation refers to such axes? Nothing will bring this so clearly before the mind as the following procedure. On a piece of drawing-paper plot the curve $x = y$, using rectangular axes, as in Fig. 6. On another sheet plot the line having the same equation, but using oblique axes, as in Fig. 7. Now trace this latter line on a piece of tracing-paper, drawing in only the line itself, the point O, and the axis O X, and place this tracing on the former line, so that the point O and the line O X of the tracing coincide with the same on the drawing. The same thing should be done with the points P, Q, R, S, T, K, M, N in Figs. 5 and 7; care being taken in each case to use the same scale on all four axes, O X and O Y and O X^1 and O Y^1.

In Fig. 6 we have three lines drawn which have one point common to all—the point O or (0, 0). Again, let it be remarked that the axes of reference O X and O Y must be imagined as extending to infinity, right and left, and up and down, and the equation $x = y$ means an infinite straight line, of which the line O D F is only a part. What have we to say of the line O A B C? What are these points: O is (0, 0); A is (1·45, 2·5); B is (2, 3·46); C is (2·9, 5);

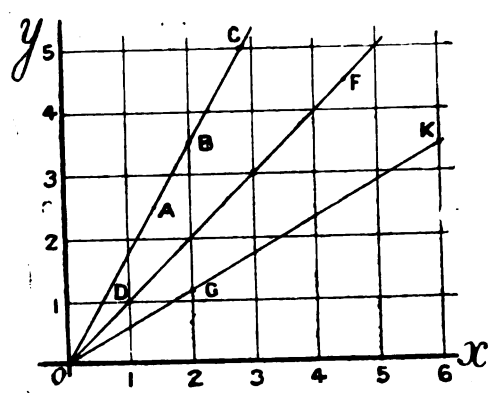

FIG. 6.

and we see there are points (1, 1·73), (3, 5·2), (1·73, 3), (2·3, 4) all on this line. If we tabulate them, the third column suggests itself at once.

x	y	$\frac{y}{x}$
0	0	anything
1	1·73	1·73
1·45	2·5	1·72
1·73	3	1·73
2	3·46	1·73
2·3	4	1·73
2·9	5	1·72
3	5·2	1·73

Here is a noticeable thing. The Y ordinates of all these seven points have a fixed relation to their X ordinates. Of course, when we are working on so small a scale we cannot be very accurate, and if the figures for $\frac{y}{x}$ be worked out to several places of decimals they will not appear to agree so well as in our table, which shows only two discrepancies—viz., points A and C. But then it must be remembered that we cannot measure values of x and y to more than one place of decimals at all accurately. Even the second is a guess, so that it is absurd to expect a quotient of two such approximations to be accurate to the second place, and they are unlikely, even in the first place, to give absolutely concordant results.

With the scale at our disposal, however, we may state that $x \times 1{\cdot}73 = y$, and put all discrepancies down to errors in reading. Take the points G and K and fill in other points on this line and tabulate them as in the above example, and we find for this line that $x = 1{\cdot}73\,y$. If it be now stated that the equation to either of these three lines may be written $a\,x = b\,y$, it must be at once evident that such a statement is true; for the line O F, a and b both = 1; for O C, $a = 1{\cdot}73$ and $b = 1$; for O K, $a = 1$ and $b = 1{\cdot}73$. Again, nothing brings this sort of thing so well home to the perception as actually drawing these lines and measuring them up. Draw also lines with various other slopes, but all passing through O. To most readers it is apparent that $\frac{y}{x}$ always gives a number equal to the tangent of the angle which the line makes with O X—*e.g.*, 1·73, or $\sqrt{3}$, is tan 60deg., and the angle C O X, is 60deg. as nearly as can be; also tan 45deg. is 1, and the angle F O X is 45deg.

We now have evidence sufficient for our purpose to enable us to state that for all straight lines passing through O the equation is $y = m\,x$, where $m = \frac{a}{b}$, the a and b being those of the equation $a\,x = b\,y$. Again, this is not a proof but "sufficient evidence for our purpose."

Let us now take our equation $y = m\,x$, and see if it suits any of the lines in Fig. 8. Take M Q P S. The values of the X and Y ordinates of the points on this line are indicated approximately on the diagram, but measured carefully come as follows: M = (− 1·58, 0) all distances to the left of O being considered negative as stated above, hence the X ordinate of point M is − 1·58; Q = (0, 0 9); P = (2 9, 2·55);

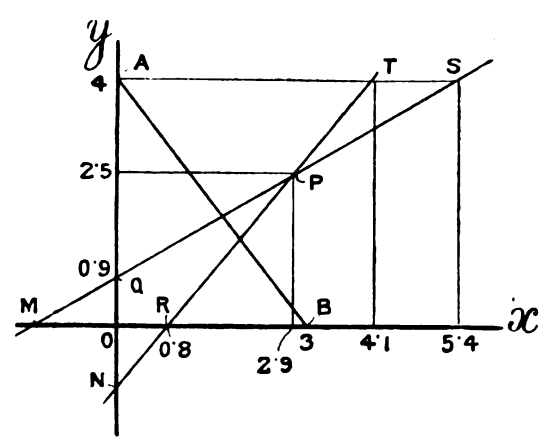

FIG. 8.

S = (5·45, 4). The very first point does not fit the equation, for if $y = 0$, $m\,x = 0$, and since we can see that here $x = -1{\cdot}58$, M must = 0; now we saw that m meant the tangent of the angle, and therefore if $m = 0$, the angle must be that whose tangent = 0; this is the angle 0deg., and a line at 0deg. with O X lies on O X. But M Q P S does not lie on O X, so the equation does not fit this line, and cannot therefore be used to represent it. By again having recourse to tabulation we may get a clue:

Point.	x	y
M	−1·58	0
Q	0	0·9
P	2·9	2·55
S	5·45	4

As a matter of fact, it is somewhat absurd to suppose that the general expression for a straight line could ever be arrived at without mathematics, and simple though the mathematics needed for this are, mathematics are in these articles forsworn, and we can therefore only beg the question. Let it then be pointed out that if m is to have a value other than 0 in the point M, we must add or subtract something to or from y, and if we did this at Q we could also make the equation fit. This point Q will perhaps help us; x is 0, and yet y has a value greater than 0; $m\,x$ is = 0 for any value of m when $x = 0$, so let us write $y = m\,x + 0{\cdot}9$; now we are safe at this point; $m\,x = 0$ and $y = 0\,9$, and obviously $0{\cdot}9 = 0 + 0\,9$. Let us see if subtracting this figure in the case of the point M gives a concordant result: $y = mx + 0{\cdot}9$, or $m\,x = y - 0{\cdot}9$; at this point M, $y = 0$, so $m\,x = 0 - 0{\cdot}9$, $m\,x = -0{\cdot}9$, $m = \frac{0{\cdot}9}{x} = \frac{-0{\cdot}9}{-1{\cdot}58} = 0{\cdot}569$; we see that

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by using this value for m—viz., 0·569—and adding 0·9 to x we get a value for y which fits both these points M and Q; a little arithmetic shows that it fits the points P, S equally well. For this line then we write $mx+0{\cdot}9=y$. By an exactly similar process of reasoning and using the points N and R to help us as we did Q and M above, and on measuring carefully to find N is (0 – 0·971), R is (0·8, 0), P is (2·9, 2·55) as before, and T is (4·1, 4), we are able to arrive at the expression,

$$1{\cdot}214x - 0{\cdot}971 = y \text{ for the line N R P T.}$$

This is the same shape of expression as that for the straight line, M Q P S, and if we wish to state it, so that we can use it for any straight line on filling in the proper figures, we must use a letter for that quantity which has to be added or subtracted to or from mx; call it h, then we write $mx+h=y$, and if we draw any straight line on our sheet of paper and produce it to cut the axes of X and Y, these points of cutting will always enable us to find the correct values for m and h to make the equation fit the line. It must be evident by now that h is the value of y where the line cuts O Y. This in the three straight lines of Fig. 6 is O. In the case of the line A B (Fig. 8) h must then be 4; $mx+4=y$, and at the point B, $y=0$, and $x=3$, so $m=-\frac{4}{3}$; this negative value for m indicates that the angle A B X is greater than 90deg.

(To be continued.)

ALIOTH ALTERNATING-CURRENT DYNAMOS.

We illustrate herewith the alternating-current dynamos which have been made by Messrs. Alioth and Co., of Münchenstein, near Basle, in connection with the electric transmission plant which utilises the water power of the Reuse for the transmission of electrical energy to Neuchatel, a distance of 36 miles.

The general design of these alternators can be readily seen from Figs. 1, 2, and 3, which are appended. The bed-plate, which is box-shape, supports two pedestals, on which are placed self-oiling bearings.

After the coil is taken from the former it is insulated by many layers of paper and varnish before being placed over the projecting pole of the armature. This arrangement facilitates repairs—a coil can easily be withdrawn and a new one substituted in case of need.

The magnetic field in the centre of the armature is mounted on the main shaft, and has 18 or 12 poles according as the generator is designed for single-phase or three-phase currents. In the first case the 18 armature coils are grouped in two series of nine each. In this way the difference of potential between neighbouring bobbins is a minimum, and each of the two series are connected in parallel. In the second case, every third coil of the 18 bobbins are grouped in three sets. As each third bobbin

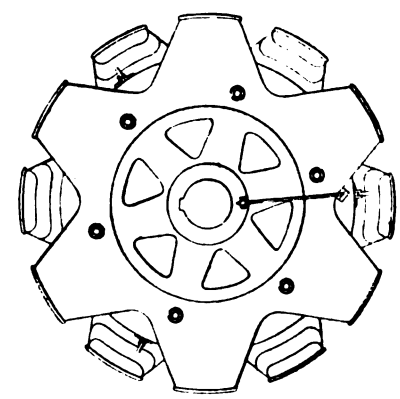

FIG. 1.—Magnet Stars for Three-Phase Work.

will in this arrangement be in the same phase, they are connected in series. Each of the three circuits are connected at one end, leaving thus three terminals furnishing three-phase currents. The alternator shown in Fig. 3 is designed for single-phase work, while Fig. 1 is the magnet star for three-phase work.

The whole of the poles of the one polarity are made in one casting of soft steel. The external faces of the pole-pieces are laminated with thin sheet iron let into the cast steel. The two star castings, one containing all the north poles and the other all the south, are strongly bolted together and mounted on a cast-steel centre, which is

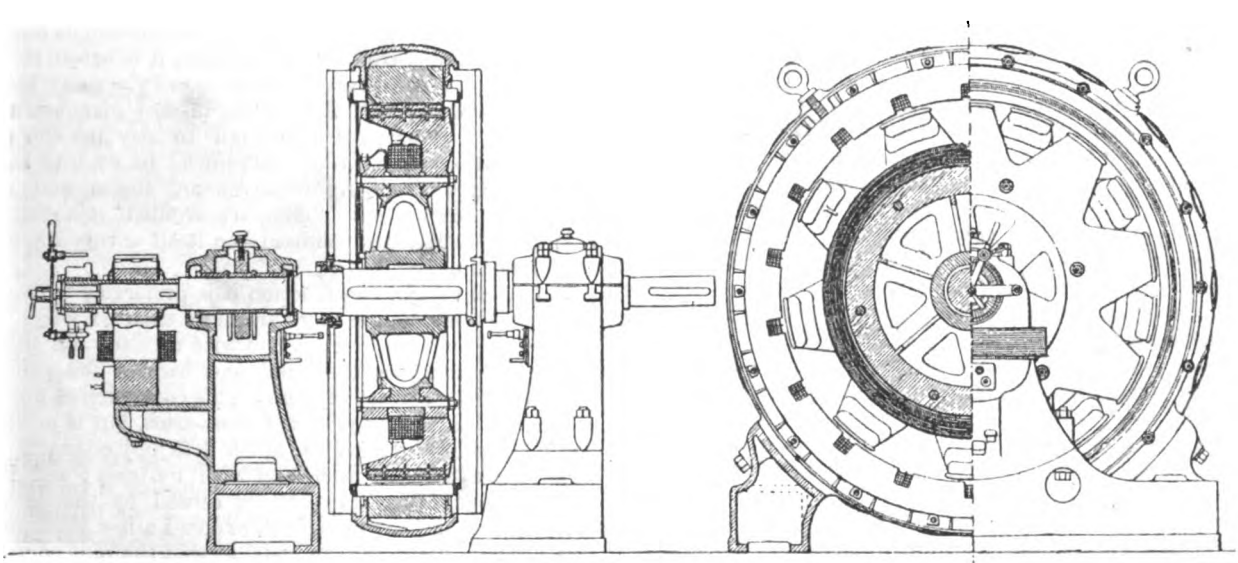

FIG. 2. FIG. 3.

The Alioth Alternator and Exciter Combined.

The bed-plate also supports in a plane perpendicular to the axis a protecting cylinder containing numerous openings for ventilation, and supporting the armature core. This has 18 polar projections radial to the axis and projecting towards the centre to carry the armature coils. The whole is of cast iron, except the iron core of the armature, which is made of laminated wrought-iron sheets, 16 mils thick, insulated from each other.

Each armature coil is wound on a wooden former of the correct shape, and consists of 60 turns of insulated copper wire, of a total length of 286ft. and of ·138in. diameter.

keyed to the shaft. In this way alternate north and south poles are obtained round the magnets.

On the periphery of the centre casting is placed the exciting coil. This is composed of 526 turns of insulated copper wire ·177in. diameter. The exciting current required is 20 amperes at 120 volts, and is supplied by brushes to collecting rings on the shaft. The exciting dynamo is mounted on the continuation of the shaft, as shown in Fig. 2, and is of such dimensions as to be able to excite two of the alternators at the same time. All the circuits are most carefully insulated from earth.

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NOTES ON THE RECONSTRUCTION OF A SMALL CENTRAL-STATION PLANT.*

BY FRANKLIN L. POPE.

(Concluded from page 104.)

It has been found to be desirable to use a lamp of rather low efficiency for the street-lighting service, as there is always danger of leakage and short-circuits from wet boughs of trees and other objects getting into contact with the wires, and thus diverting an abnormal current through some portion of a lamp circuit. In such case, a lamp of high efficiency is pretty certain to be burned out, or at least to have its career of usefulness materially abridged. In this plant the average consumption of energy in the street lights, including lamps, lines, shunts, and leakage, is found to be about 140 watts per lamp of 32 c.p.

Perhaps the most ticklish part of the whole undertaking was the changing over of the Westinghouse system, which was a 1,050-volt primary and a 52-volt secondary, running at 16,500 alternations. In accordance with the new plan it was of course necessary to double the pressure both in the primary and secondary circuits, and to substitute 104-volt for 52-volt lamps throughout. A preliminary test of one of the transformers demonstrated that which perhaps might have been foreseen from theoretical considerations—viz., that a dangerous quantity of heat was developed within a few hours when it was used to convert from 2,000 volts down to 100. In order to utilise so far as possible the old transformers, and at the same time avoid the above difficulty, various expedients were resorted to. Wherever a group of consumers was located in one neighbourhood a pair of large transformers were installed, with secondary mains extending from 500ft. to 600ft. in various directions, these transformers being, of course, placed in series with each other. Scattered consumers, as far as practicable, were connected together in small groups, and supplied by a pair of small transformers coupled in the same way. The Westinghouse meters, having been originally constructed for a frequency of 16,500 alternations, ran slow when the frequency was reduced to 8,000. The necessary coefficient for correction of the readings was easily ascertained by experiment, and as fast as possible the meters were fitted with new discs, supplied by the Westinghouse Company at a trifling expense, and adapted to the lower frequency.

Of course, it will be understood that the reason for resorting to these various shifts and expedients was merely that we might utilise the old apparatus as far as it could possibly be done, and also that we might carry on the work of reconstruction for the most part with the ordinary working force of the establishment.

The horizontal double turbine, which is used to drive the two-phase generator, has done such good work that it deserves a few words of commendation. The selection of the best among the many available types of turbines for electric work is a matter which merits far more consideration from a scientific standpoint than it generally receives. Waterwheels, like dynamos and motors, are sometimes sold on commission by agents, and it not infrequently happens that the salesman who makes the largest "claims," especially if he sells his goods the cheapest, carries away the contract. It needs to be said, however, that there is a far greater difference than is often suspected in the amount of work different types of wheels will do with a given, and especially a limited, amount of water. There are, furthermore, a great many types of wheels in the market which, although as efficient as could be asked for with a full volume of water, are very far from being so when the volume of water is reduced even by a comparatively small percentage. It is but just to say that it is seldom that a turbine makes so favourable a showing, not only in this but in other respects, as the one provided by the company from which we lease our power. The following figures are selected from a much larger number obtained by actual measurement of its performance in the testing flume of the Holyoke Water Power Company.

Head acting on wheel, feet.	Revolutions per minute.	Quantity of water passing through wheel (cubic feet per second).	Horse-power.	Per cent. of efficiency.
16·66	156·25	81·75	124·50	80·99
16·80	155·00	70·79	109·37	81·18
17·02	154·50	63·42	95·86	78·39
17·26	156·75	52·19	73·42	71·95
17·44	152·25	42·55	53·71	63·90

These results are worthy of particular note, for the reason that they show a very high percentage of efficiency maintained through a wide range of variation in the quantity of water passing through the wheel—a most valuable characteristic for electric work. When the quantity of water used was diminished from 81·75 to 42·55 cubic feet per second, the percentage of efficiency fell only from 80·99 to 63·9, and, what is even more remarkable, it was found that the efficiency remained well above 80 per cent. over a range of variation of discharge from 83·22 to 70 cubic feet per second, or 15·9 per cent. More than one type of turbine which enjoys a high reputation and extensive sale among manufacturers will not reach 65 or even 60 per cent. efficiency at "three-quarter gate," while the 33-minute wheel above referred to has been found to give by actual test 78 per cent. under similar conditions.

The turbine carries upon its shaft a driving pulley 100in. in diameter, weighing 11,000lb., which serves as a balance wheel. It is also provided with a Replogle electric governor operated by three cells of gravity battery, which has never failed to do its work quickly and certainly, even under trying conditions.

In carrying out this work, some things have been learned by experience which may be of use to others called upon to advise or to undertake the construction of similar works, and I will therefore venture to summarise some of my conclusions as follows:

1. In considering the advisability of operating an electric plant by water power, do not on any account neglect to ascertain from authentic sources of information just how much water can be depended upon during the low stage in an extra dry year, for this is the measure of its value for electric work, except when used as an auxiliary to steam. The ordinary estimates of the commercial value of a water power are only too apt to prove preposterous exaggerations.

2. If rights-of-way or releases of damages can be obtained without too much trouble and expense, it is better to build the feeder line as directly across country as may be than to follow a highway. The saving in cost of construction will usually be more than enough to pay for the right-of-way, and on such a route there need be no interference from trees, while many inconvenient angles and much trouble in guying and bracing are avoided. Shorter and stouter poles may also be used—in itself a very important consideration.

3. In electric line construction it is preferable to dispense with cross-arms, unless there are more than six wires. The best arrangement is to place one wire on a top pin and the others alternately on the front and back of the pole, at a vertical distance apart of 12in. This construction not only costs less than properly-braced cross-arms, but is much less conspicuous and therefore much less objectionable in a public street; is less interfered with by trees; and is far more durable. Much trouble is caused by the decay of cross-arms after they have been exposed a few years to the weather; they split at the ends, so that the pins come out, and not infrequently break in the middle, thus fouling the wire.

4. In medium-sized towns and cities, especially in shaded streets, the incandescent lamp may be made to give a far better distribution of light for the same money than is possible with the "half-arcs" so extensively used, and is much less troublesome to maintain in good working order. My own experience leads me to think that the lamps ought not to be of less than 24 c.p. or more than 32 c.p. Use lamps of low rather than high efficiency, but run them at full candle-power, or even a trifle above. Good street lights, well arranged, and renewed sufficiently often, are the best possible advertisement for any electric company.

* Paper read before the American Institute of Electrical Engineers, Niagara Falls, June 27, 1895.

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5. Use large transformers as far as practicable, placing the consumers within 500ft. or 600ft. radius upon secondary mains. We have used both two-wire and three-wire mains. The latter plan is certainly to be recommended when the distance approximates or exceeds 500ft., but for short distances—as, for example, when distributing within a single block at a pressure of 100 volts or more—it is a question whether the gain in cost of copper over the two-wire plant is of sufficient importance to offset the additional complexity.

6. It was found that raising the voltage in the residence district from 1,000 : 50 to 1,000 : 100 greatly improved the uniformity of distribution by lessening the potential drop without entailing any corresponding disadvantages. It would seem to be preferable on every account to use the higher pressure.

7. One of the most important minor points in the management of a plant is apt to be too much neglected—the maintenance of the insulation of the wires by promptly replacing all cracked and broken insulators, and by keeping the wires absolutely free from contact with uninsulated objects. The covered wires which lead into the hoods of the street lamps need to be carefully looked after.

8. Number all the poles with yellow paint applied with a stencil on a black ground; and keep a record book of the position of each one and its distance by the line from the test station.

9. In selecting a turbine wheel, consult competent authorities as to the available fall and minimum quantity of water, and when making the purchase do not expect to get a 1,000dol. wheel for 100dol. Pay a fair price, and insist not only that the wheel shall be well made in every way, but that it shall be tested by an expert before acceptance. If it does not give an average efficiency of 76 per cent. between half gate and full gate, it is not advisable to accept it, inasmuch as you can easily do better, as our own experience proves.

10. I think our experience shows that it is possible to largely increase the net earnings of an old plant without necessarily refitting it throughout, but plenty of time should be taken for consideration as well as for execution in order to secure satisfactory results with a moderate expenditure.

THE QUALITIES OF MANGIN AND PARABOLIC MIRRORS.

We have received the following communication from Herr F. Nerz on the above subject:

A reply was published in the *Electrical Engineer* of July 5, by M. J. Rey, chief engineer to Messrs. Sautter, Harlé, and Co., Paris, to my communication in the same paper of June 14.

The last statement of M. Rey calls for some corrections.

It is true that I was not allowed, as an expert of the Elektrizitäts-Aktiengesellschaft vormals Schuckert und Co., of Nuremberg, to attend the comparative trials carried out at Toulon, although the French firm Messrs. Sautter, Harlé, and Co. were allowed to be represented as they liked. My firm, in spite of this, trusting to the honour and impartiality of the French Marine Commission, allowed their projectors to be available. In handling these, only persons of French nationality were employed, who were instructed by me before the trials in Toulon, and during the period of the same in the use of projectors, as they were not versed in the technicalities of projectors. It is self-evident that by this dissimilar representation of the competing firms, the French firm obtained a favourable position. Long before the trials, in reply to a question of Messrs. Schuckert and Co., the French marine authorities fixed the current to be chosen for the projectors, and consequently our representative acted correctly in, as requested, not furnishing a current of greater intensity than 100 amperes for the mirror of 38cm. That this was not due to fear that the mirror could not withstand the heat is contradicted by the fact that Messrs. Schuckert recommended up to 120 amperes for 38cm. mirrors in cases where diffusers were to be employed, and apparatus of this kind have been delivered in numerous instances.

M. Rey is in error when he maintains that I adduced as the chief advantage of the parabolic mirror that it had a short focal length. In my paper "Scheinwerfer und deren Verwendung" I expressly stated: "The greatest advantage of the parabolic mirror, as compared with the Mangin mirror, is that its construction adapts itself to the demands of theory. All that is required is to choose for a given diameter of mirror the correct focal length, so as to secure the greatest possible performance."

In the same place I have indicated how the proper proportion between the diameter of the mirror and the focal length is to be obtained. That Messrs. Schuckert and Co. at the present time make mirrors of 90cm. diameter and 31cm. focal length, can be found by M. Rey in the projector tables published by me. The grounds why in one case larger and in another case smaller focal lengths are to be chosen may be obtained from my previous publications and those of my firm. Should, however, a reader put the question why Messrs. Sautter, Harlé, and Co. in their mirrors always aimed at reducing the focal length, M. Rey would have to give a reply which would differ little from my statements.

With respect to M. Rey's enquiry as to the degree of accuracy in parabolic mirrors, I can reply that the actual focul lengths of the separate mirror zones differ from those aimed at only by amounts lying in a circle of 1mm. radius. In connection herewith, I must state that the focul lengths aimed at do not unite at one common point, but that according to the different diffusion of the separate zones of the parabolic mirror, the focul lengths of the same are shifted on the axis of the mirror. By this arrangement it is possible to correct the unequal illumination of the rays of light produced by a mathematically accurate parabolic mirror within fixed boundaries—that is to say, to raise the homogeneity of the rays of light as required, as I have already shown in my previous communications in correction of Messrs. Sautter-Harlé's fifth paragraph.

As regards the conditions laid down for the delivery of glass parabolic mirrors for a Government, M. Rey is correctly informed with regard to the figure of 7mm. This figure, however, does not refer to a sphere within which the rays from an infinite distance unite, but to the section of the axis in which this is cut by the various reflected rays. With rays which according to conditions of delivery are thrown back with very small axis angles, a removal of the cutting point by + or − 3·5, in all 7mm., results in a very small deviation.

This circumstance neither M. Rey's guarantor nor M. Rey himself has forgotten to take into consideration. Far from me be it to make M. Rey an adherent to the parabolic mirror, and therefore I desist from going more closely into the separate points of his last communication. Time, which has converted M. Rey or his firm from enmity to the horizontal lamp to friendship for the same, will also shortly bring about conversion to the parabolic mirror.

But with respect to the Toulon trials, I must return to this subject. M. Rey maintains that I have been falsely informed by my company's agents, and that the experiments were not favourable to the parabolic mirror. This I contradict, and in support adduce decisions the competency of which cannot be denied by M. Rey: (1) the competent French authority speaks explicitly of the superiority of our glass parabolic mirror—if this superiority had not been considered great enough to introduce the glass parabolic mirror into France in place of the Mangin mirror, then certainly no reference would have been made to the superiority if this had not been proved; (2) M. Rey himself has in Toulon admitted to me, in the presence of witnesses, the superiority of our glass parabolic mirrors.

The Toulon trials have shown that a 65-ampere parabolic mirror gave the same results as an 82-ampere Mangin mirror, and demonstrate only the correctness of the results which had been obtained elsewhere, which showed the superiority of the parabolic mirror.

A New Telegraph Line.—The Government of India have approved of the construction of 162 miles of telegraph line from Hoti Mardan to Chitral.

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NOTES ON HYDRAULIC POWER SUPPLY IN TOWNS—GLASGOW, MANCHESTER, BUENOS AYRES, ETC.*

BY EDWARD B. ELLINGTON.

The distribution of hydraulic power in towns has not previously been brought directly before the members of this institution, and the fact that works of this character have just been completed in Glasgow renders the present meeting a suitable opportunity for dealing with an engineering subject of such continually increasing importance.

Existing Hydraulic Power Works.—The present position of the various undertakings which have been established for this purpose is summarised in the accompanying Table I.

TABLE I.—Existing Hydraulic Power Works.

Place.	Year of establishment.	Length of mains.	Largest diameter of mains.	Engine horse-power.	Delivery of water per week.	Number of machines worked.	Pressure per square inch in mains.
		Miles.	Inches.	I.H.P.	Gallons.	No.	Lb.
Hull	1877	2½	6	250	100,000 to 500,000	58	700
London	1884	76	7	3,400	9,500,000	2,300	750
Liverpool	1888	18	6	800	1,000,000	453	800
Melbourne	1889	18	6	800	1,500,000	413	750
Birmingham	1891	3½	6	52	78,000	—	700
Sydney	1891	12	6	688	740,000	200	750
Antwerp	1894	4½	12	1,000	3,300,000	Turbines at three stations	750
Manchester	1894	12	6	800	1,000,000	247	1,120
Glasgow	1895	9	7	600	Nil	Nil	1,120

General Arrangement.—Of the hydraulic power works in London full particulars have already been given to the Institution of Civil Engineers, and as all such works have much in common it is hardly necessary to add any detailed account of the most recent establishments in Glasgow and Manchester. The supplies in these towns differ from those given elsewhere in the higher pressure employed—namely, 1,120lb. per square inch. This pressure was adopted in Manchester on the recommendation of the author and his colleague, Mr. Corbet Woodall, in order to render the power available under the most economical conditions for working the numerous hydraulic packing presses within the area of supply in that city. The works in Manchester have throughout been carried out under the supervision of Mr. Woodall, acting for the Corporation. In Glasgow also there is a considerable demand for power for pressing; and Mr. Gale, who is here responsible for the general scheme, considered it advisable to be able to supply the same higher pressure. The plans and specifications for these works were prepared by the author's firm as consulting engineers, and their execution has been under the control of the water department of the Corporation, and especially of Mr. Cochrane, Mr. Gale's assistant mechanical engineer. The general arrangement of the works in Glasgow and Manchester was shown by diagrams. The engine-house in each city is laid out to contain six sets of vertical triple-expansion engines of 200 i.h.p. each, of the kind introduced by the author in 1880, but in the earlier engines the cylinders were arranged compound with one high-pressure and two low-pressure cylinders. The scale on which the two stations have been planned is the result of the experience gained in London, which has demonstrated that for hydraulic power supply a station of about 1,200 h.p. is the most economical both in working expenses and in outlay of capital.

Engines.—The principal dimensions of the pumping engines in Glasgow are as follows: high-pressure cylinder 15in. diameter, intermediate 22in., low-pressure 36in., and all three 24in. stroke; cranks set at 120deg. in the sequence—high, low, intermediate; pumps, single acting, 13in. diameter and 16in. stroke; surface condenser, 530 square feet of condensing surface; crankshaft journals, 7in. diameter; flywheel, 7ft. diameter, weighing two tons. The engines are designed to work with a steam pressure of 150lb. per square inch above atmosphere, and this is the boiler pressure adopted in the recent stations in London and Glasgow; but in Manchester the pressure of only 120lb. is used, at the request of the committee of the Corporation who had charge of the undertaking. The Glasgow engines have not yet been tested for economy, but the London station of similar character at Wapping gave a consumption of 14·1lb. of water per indicated horse-power per hour (*Proceedings*, 1894, pages 536-51).

Boilers.—The boilers in Manchester are of the usual Lancashire pattern, five in number, 7ft. 6in. diameter and 30ft. long. In Glasgow, as coke breeze is to be used for fuel, and as there is ample space under the reserve water-tanks, it was determined to arrange the house for eight Lancashire boilers, 7ft. diameter and 30ft. long; at present only four have been fitted for the three sets of engines already in place. Since the station was designed, the Corporation have determined to add to the boilers Watmun automatic circulating apparatus for increasing their efficiency. Both in Manchester and in Glasgow two of Green's economisers, with 160 tubes each, have been fitted at the back of the boilers. In the recent Wapping and City-road stations in London, Fairbairn-Beeley boilers have been used, and these with the economisers have given under trial the remarkable result of 11·11lb. of water evaporated from the temperature 63·5deg. of the hot-well feed, and at the temperature of 362deg. corresponding with 143·3lb. pressure above atmosphere, or 13·44lb. of water evaporated from and at 212deg. with 1lb. of dry Nixon's coal, having a calorific value of 15·5lb.; the thermal efficiency of the boiler was therefore 86·7 per cent. It will be interesting to compare this result with that of the Glasgow boilers when they can be tried.

Accumulators.—The accumulators at the Manchester and Glasgow stations are of the same capacity—namely, two at each station, having rams 18in. diameter and 23ft. stroke, and each loaded with 127 tons inclusive of ram and casing.

Delivery.—Each set of engines is designed to deliver 230 gallons per minute at a speed of 60 revolutions, or 240ft. of piston; but it is not intended that they should be run in regular work at more than 50 revolutions, or 200ft. per minute. Assuming that five engines are working at the same time, the total regular working capacity of the stations when fully equipped is 57,500 gallons per hour at 1,120lb. per square inch. The maximum recorded during regular work in an hour at the Wapping station of the London Hydraulic Power Company with five engines running has been 66,000 gallons at 800lb. per square inch, or an average for each of the five engines of 45 revolutions per minute. The reason for dividing the power at a station into so many units is of course that the demand for power, as for lighting, is so irregular that the maximum demand is maintained approximately for only an hour or two during any day.

Site of Station.—The general arrangement of the Manchester and Glasgow stations has been determined mainly by the configuration and situation of the site selected. At first view the proposed site for the Glasgow works appeared difficult to lay out satisfactorily; but the solution ultimately arrived at, the author thinks, has fulfilled the

* Paper read at the meeting of the Institution of Mechanical Engineers at Glasgow.

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required conditions in a fairly satisfactory manner, both mechanically and architecturally. The problem was solved by dividing the site into two areas at different levels by a heavy retaining wall, and an attempt has been made to give the buildings a more imposing character than has been usual in such works. The position of the site seemed to require this, and the suggested elevation was at once accepted by the committee as being appropriate to its surroundings.

Water.—Both in Manchester and in Glasgow the water supply is taken from the corporation mains: so that no pumping is required to fill the tanks, and no filtering apparatus is needed. The whole arrangement of these stations is thereby much simplified as compared with those in London, where Thames or canal water is used; it is also unnecessary to have the same large reserve of water in the tanks. At the Wapping station in London, for instance, the tanks over the boilers have a total capacity of 237,000 gallons, and in addition there are underground reservoirs of filtered water containing 500,000 gallons. In Manchester and in Glasgow the whole storage provided is only 230,000 gallons and 200,000 gallons respectively. The pipes in the engine and boiler houses are all arranged on the duplicate or circuit system, and great attention has been given to the provision of sufficient access to all parts of the machinery.

Mains.—The supply from the stations in Manchester and Glasgow is taken to the streets through four mains, which are laid in circuit, with valves at intervals of about 440 yards. Connecting mains have a valve at each end, so that the majority of buildings supplied have two ways by which the power can be obtained. The largest mains laid in Manchester are 6in. internal diameter, and in Glasgow 7in. The reason for the adoption of 7in. mains in Glasgow is that there is a tendency to reduction of bore through corrosion due to the action of the Glasgow water; in consequence of which Mr. Gale wished the mains to be larger than the usual size.

Joints.—The joints of the pipes are precisely the same as those used for the lower pressures in London and elsewhere. The packings are guttapercha rings inserted in a V groove, and the pipe ends are spigot and faucet. The setting back of the flanges, so as to leave a considerable projection of the pipe ends beyond them, has greatly strengthened the pipes, without adding any weight; and so far as is known, only one failure of a pipe flange made on the author's plan has occurred during the last 10 years. This failure occurred through a settlement in Bishopsgate-street, London. With pipes made without the flanges set back, many failures have occurred.

Registration of Supply. — Always supposing that the demand for the power is large enough, the commercial success of public hydraulic power stations is largely dependent upon the proportion of the total output which can be accounted for by the meters employed. It is impossible to maintain a high efficiency of the machinery in use without a great deal of time and attention being given to the registration of the supply. The means employed for registration, therefore, and for the maintenance of efficiency, are of great interest and importance in connection with the distribution of hydraulic power. This particular question has not been previously dealt with by the author so fully as to render it superfluous to revert to it here. The London supply of power is so largely in excess of anything required elsewhere that the experience gained in London is the most valuable, and the present remarks on this head will apply mainly to London.

Efficiency.—The first two matters to determine are the quantity of power delivered by the engines into the mains, and the rate of flow as far as possible throughout the day. The quantity of power is ascertained by a record of the engine revolutions obtained with the usual counters. A constant is used, which for the London engines is reckoned as 4·8 gallons per revolution. This constant has been verified from time to time by observing the quantity delivered from the tanks during some hours by direct measurement, and no alteration is allowed in this constant under any circumstances. The counter readings are taken in London at six o'clock in the morning and six o'clock at night, and are entered in the engine-room log-book. These readings give the amounts from each station every 12 hours, and the returns from the several stations are collected and entered in a general log-book. Every six or seven weeks the meters are read on the consumers' premises, and the totals are collected, and the efficiency of the system is determined by the fraction representing the ratio of the quantity registered by the meters to the quantity pumped as determined by the counters. This ratio in London is found to vary considerably in different quarters of the year, and in different years. It has never been higher in any quarter than 0·9826, and has never been lower than 0·8560. The following are the ratios of efficiency for the 10 years 1885 to 1894 in London, and for six years in Liverpool:

	London.	Liverpool.
1885	0·8665	—
1886	0·9250	—
1887	0 9400	—
1888	0·9370	—
1889	0·9545	0·945
1890	0·9576	0·959
1891	0·9089	0·9853
1892	0·9240	0·9304
1893	0·9119	0·9543
1894	0·9181	0·9592
Average	0 9243	0·9555

The causes which produce the variations in these ratios of efficiency are themselves very variable, and with an extensive supply, such as obtains in London, it would be almost impossible to identify the locality of the losses if the record of daily deliveries and the quarterly reading of meters were all there was to depend on. The sources of waste and error are of two kinds: firstly, those which occur before the supply reaches the consumers; and secondly, those which appertain to the consumers' machinery and to the meters. The losses of the first kind are made up of leakage past the suction-valves of the pumps; of leakage in the mains, and in the packings of the valve glands connected with the mains; and of losses in frosty weather by pumping water to waste for the purpose of maintaining the circulation. The losses of the second kind are due to defects in the registration by the meters; to leakage from consumers' machines, where, as is generally the case, the exhaust water only is registered; and to drainage from consumers' machines and pipes. The last loss is considerable in winter, when consumers make a practice of draining their pipes after work every day.

Automatic Flow-Recorders. — In order to maintain a sufficient control over all these sources of waste, it is of the first importance to know the minimum flow through the mains at times when it may be supposed that no work is being done. To ascertain this, automatic recorders are fitted at all the pumping stations. One of these consists of a drum, actuated by a clock, and carrying a paper strip, which is divided into quarters of an hour and hours by pins fixed on the drum; and over the drum are a series of armatures carrying pins, which prick a hole in the paper as each engine completes 100 revolutions. The descent of the armature is determined by electric contact, and one armature is electrically connected with each engine. The clocks at the different stations are synchronised, and the paper tapes are cut off daily, and the maximum and minimum deliveries during an hour are registered daily. The maximum delivery is chiefly used for determining load-factors, and the amount of power required for supplying a given number of machines; while the minimum daily registration is of the greatest value in determining the condition of the whole system, including the consumers' own machinery. The minimum flow varies greatly from day to day, but it never falls below a certain amount. This mode of registration was introduced by the author in 1888, and it has been found that the minimum flow rises pretty regularly as the supply is augmented. The following are the maximum and minimum registrations in London for the June quarters from 1888. It will be observed that the minimum flow has increased at a greater rate than the maximum, and that the maximum has followed fairly closely the increase in output. The latter fact is more clearly brought out by the comparison also given for the same years of the load-factor—that is, the ratio of the average flow per hour to the maximum flow.

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Year.	Total water pumped in June quarter. Galls.	Max. flow per hour. Galls.	Min. flow per hour. Galls.	Annual load factor.
1888	29,238,000	39,120	1,200	0·286
1889	39,873,000	49,920	1,776	0·328
1890	48,172,000	61,248	1,604	0·306
1891	65,386,000	79,330	3,360	0·339
1892	77,103,000	91,920	3,984	0·326
1893	82,586,000	101,760	4,500	0·323
1894	96,876,000	114,096	4,800	0·338

The causes which have led to the comparative increase in the minimum flow since 1890 have been extremely difficult to ascertain. Since 1890 a great deal more hydraulic power has been used at the stations themselves, because most of the water from the river has since then been pumped into the unfiltered-water reservoirs by means of hydraulic pumps; but as the hydraulic power so employed is registered, this should not have affected the ratios of efficiency, which have been lower for the years 1891-94 than in 1887-90. Recently, arrangements have been made to stop for one hour on Sunday morning all use of hydraulic power at the stations, and during the current year the minimum flow has fallen to 4,080 gallons in the hour, with a delivery of 112,000,000 gallons in a quarter, and a maximum flow of 144,000 gallons per hour. These figures show as good a result as in any previous year. From such facts as these, and for other reasons, it appears probable that the principal cause of the difference is to be found in the meters and in the consumers' machinery.

Detection of Waste.—The whole of the 76 miles of mains in London are as a rule in communication with one another; but certain valves are kept closed in such a way that the several main circuits are in communication with one another at the central station only. The superintendent at the central station has it then in his power at any time to divide the supply into four distinct sections, and by observation of the pressure gauges it can readily be ascertained through which section an abnormal flow is occurring. The main in which this abnormal flow is proceeding has then to be shut down at intervals, till at last the leak is run to earth. Great care and experience are required to determine the exact spot, as the water seldom appears through the surface of the street, and usually the only indication is the noise it makes in passing through a valve very slightly opened, which is detected through a metal rod pressed against the valve and held to the ear. Irrespective of any special indication afforded by the minimum readings, the whole of the mains are being constantly tested in this manner; but it is a work of considerable difficulty, because the supply has to be maintained as required throughout the night, and it is only during two or three hours in the early morning that anything of the kind can be done, and even then special arrangements have to be made with the consumers. The principal difficulty arises from the very small flows that have to be detected; for instance, the quantity of power water pumped into the mains and unregistered during the last quarter of 1894 was 6,900,000 gallons out of a total of 111,000,000 gallons, or 6·22 per cent.; but this 6,900,000 gallons to be accounted for by testing the mains is the result of water flowing continuously at the rate of, say, 3,000 gallons per hour, which is thus only about 2 per cent. of the maximum rate. The whole of this flow is distributed throughout 76 miles of mains, and over 2,200 machines with all their pipes and accessories. At the pressure of 750lb. per square inch 3,000 gallons per hour would pass through an orifice of only $\frac{5}{16}$in. diameter, which shows how small in reality the leakage from the mains must be. The principal source of waste is undoubtedly on the consumers' premises. It has been found necessary to inspect regularly all consumers' machinery in order to prevent waste from leaky valves and glands. Every machine from which the exhaust is measured is thus inspected every quarter, and the owners are called upon to make good defects. Many of the meters in use cannot be depended upon to register small flows, and a good deal of waste passing leaky valves thus fails to get registered; but some of the waste occurring in this way does evidently get registered, because it is almost invariably found that the quantity unregistered is less than would be represented by the minimum flow. Thus in the figures just given for the last quarter of 1894 about 30 per cent. of the minimum flow was registered. A further cause of loss has already been mentioned—namely, the drainage of pipes and cylinders on consumers' premises. This no doubt is the cause of the registrations being better in the summer quarters than in the winter. In severe frosts the drainage of the pipes and cylinders is an important matter, and it has been found advisable to facilitate the practice. There are other losses due to washing out and testing the mains, etc.; water used for testing extensions of mains is allowed for in the registered quantity. On the whole, therefore, it is no doubt a good result to have succeeded in registering an average of 93 per cent. of the quantity pumped during the nine years 1886-94.

Frost.—The severe and prolonged frost of last winter did not seriously affect the supply. About 1,150,000 gallons was pumped to waste during Sundays in order to maintain the circulation; but after allowing for this 91·65 per cent. of the total water pumped was registered. This fact alone is conclusive; but in a few places sub-mains in exposed positions were frozen, though in nearly every case they were quickly cleared. No consumer, it is believed, was seriously inconvenienced. The frost was down in the ground quite 3ft. in places, and there were five or six instances of broken mains. The damage done was greater than on any previous occasion. The surface of the roads was so hard that the water could not get through the paving, and in two or three places found its way into cellars. In two instances the water was forced between the concrete and the wood paving, floating the latter, and at last finding a vent about 100 yards away from the break. It was not found necessary to relay the pavement thus lifted, except in a few places, for it settled down all right again after the water had run off. There were other novel experiences of the severity of the weather. In the Thames Embankment subways there were several degrees of frost, and during its continuance, in order to reduce the risk, the area of supply was divided into sections, and the embankment main had thus a dead end; the temperature fell, the main contracted, a large number of the joints opened, and huge icicles formed round the flanges. As soon as this was discovered, the valve shutting off the City was opened, the water which is sent into the mains at 60deg. flowed through and thawed the pipes that had contracted, and most of the joints again became quite sound. In connection with this question of warming the water, it is interesting to note that the water pumped from the river was below freezing point. The water is heated by passing it through the surface condensers of the engines; but at the new stations where the triple-expansion engines are used, it was found that the temperature could not be raised much above 40deg. in the filtered-water tanks, and in order to maintain the water at the higher temperature of 60deg. it was necessary to destroy the vacuum in the condenser, thereby rendering the engine less economical for the time being. Another experience may be mentioned in connection with low temperatures which shows that high apparent economy is not always real economy. At the Wapping and City-road stations the economisers are arranged much in the same way as for the Glasgow works. The temperature of the gases leaving the economisers was reduced to 238deg. or 240deg., and the temperature of the hot-well condensed water entering the economiser was 65deg. or 70deg. The consequence has been that it has been found necessary to renew the economiser tubes after three years' work, owing to the condensation on the outside of the tubes and their consequent corrosion. The cost of the renewal is larger than the saving of fuel effected. Arrangements are now being made to obtain a higher hot-well temperature.

Meters.—At first sight it would appear desirable to use high-pressure meters. Where these are used, the conditions of supply are much simplified, because the condition and arrangements of the consumers' machinery are then of no direct consequence to the works supplying the power, since all water taken from the mains for any purpose is measured, and this is undoubtedly the ideal arrangement. There are, however, difficulties in the way. The high-pressure meters to stand 750lb. to 1,200lb. per square inch are necessarily costly. For hydraulic purposes it is essential, in the author's opinion, that they should be positive meters. A positive

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meter has three disadvantages: it will never for a long period register a small flow; it offers considerable resistance to the flow at high velocities; and if it gets out of order it may stop the flow almost entirely. Now, a stoppage of supply from any cause is more serious than a temporary failure to register; and the balance of advantages is found to be ultimately in favour of the low-pressure meters registering the exhaust from a tank into which the exhaust-pipe discharges. The kind of meter adopted by the author is the Parkinson, which is closely similar to a gas-meter. If it stops working the tank overflows, and the nuisance causes a report to be sent in at once. It will register every drop of water, provided the water is clean and the meter properly set. On the other hand, it takes up a good deal of room, and if dirt or rubbish is allowed to pass into the drum its accuracy is soon affected. A good deal of trouble is experienced from this cause. Where bad oil and packing are in use, or the glands and rams are in a bad condition, these meters have frequently to be changed two or three times in a single quarter, while in other places, where the machinery is better attended to, they will work for two years or more. With the Kent positive low-pressure meters, which are largely used in London, there is not the same difficulty, and in many places these are preferred, because the space taken up is so small that there is no noise from the falling water. But they do not register accurately a small flow. On the whole they are well adapted for high pressure, and in several places it is only on the high-pressure side that the power can be registered, as, for instance, at the London Docks, where only a portion of the supply is taken from the hydraulic power mains, the remainder being supplied from the dock pumping stations. The principal difficulty with high-pressure meters is in connection with the counter. The spindle must be light, in order to avoid loss of pressure, and the stuffing-box must be kept tight under the wear. After passing 1,000,000 gallons they have been found under test still accurate within 1 per cent.

Application of Power.—Hydraulic power has to be supplied under competition with steam, gas, and electricity, and the success which has attended its introduction shows conclusively that it is well able to meet this competition for lifting and for other intermittent work. None of the supply systems which have been established have aimed at meeting the demand for continuously running motors, except in Antwerp, where the supply has been laid out as a means for generating electricity for lighting. At first sight it is somewhat difficult to see how this can be an economical mode of employment. There are, however, a few places in London where the hydraulic power is used to generate electric current. The apparatus consists of a Pelton wheel, with the armatures of the dynamo mounted on the same shaft. The following are the particulars of a trial made with this apparatus at the hydraulic engineering works at Chester in October, 1894: Pelton wheel, 18in. diameter, 54 buckets; Elwell-Parker shunt-wound dynamo for charging accumulators, having a commercial efficiency of 87 per cent. as tested by the makers; speed, 1,671 revolutions per minute; bore of nozzle, 0·175in.; hydraulic pressure, 725lb. per square inch; output, 37½ amperes at 120 volts; water consumption, 20 gallons per minute; power in water 10·15 h.p., in output 5·99 h.p.; efficiency, 59 per cent. This is not the highest efficiency that could be obtained, for the wheel and dynamo were not perfectly adapted to each other. External resistance had to be used for keeping down the voltage, and at this output the dynamo was somewhat overworked. In a previous trial, with 0·16in. nozzle and an output of 26 amperes at 122 volts, the efficiency was 59·86 per cent. It is unlikely, however, that even under more favourable conditions the conversion can be effected with a greater efficiency than 66 per cent.

(To be continued.)

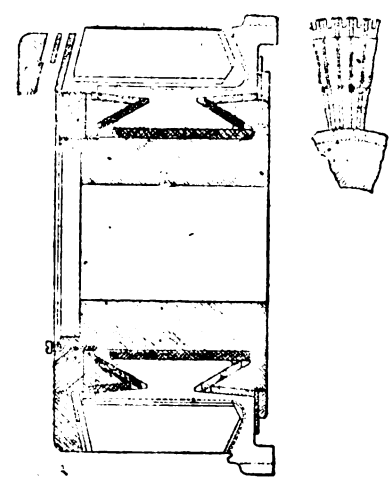
Electric Railways in Germany.—According to the *Berliner Tageblatt*, the directorate of the Lübeck-Büchen Railway purposes introducing electric traction on the line between Hamburg and Lübeck; and the State railway authorities intend, it is said, to electrically haul the trains running between Hamburg and Harburg.

COMMUTATOR WITH MOVABLE SEGMENTS.

Any arrangement whose object is to relieve the owner of a dynamo or the manager of a central station from care or responsibility is worthy of attention. A description, therefore, of the Painter-Morrison movable-segment commutator will be interesting. This commutator differs from the type at present in use in that where renewal is essential it is not necessary to disengage the armature wires from their segments. This operation, it is well known, is frequently as tedious as it is troublesome; it is more or less injurious to the wire; and it occupies considerable time, during which the dynamo is useless. The new arrangement, while obviating these difficulties, also results in economy being attained by permitting the utilisation of all the material save about a tenth of the thickness of the segments.

Figs. 1 and 2 show, in cross-section, the method of construction. As will be seen, the central bushing is fixed and maintained in position in the same manner with existing types, the only difference being that the contact surface is plane from one end to the other. Each segment is, on two sides, shaped into a double bevel, which engages in two V grooves. In order to renew the commutator it is not necessary to withdraw the tube or bushing from the shaft, nor to detach the wires.

The segments are all of the same size. They can be joined beforehand in the form of a ring held by a hoop and slid altogether on the bushing, as shown in Fig. 2, or mounted separately on it. The fixing shield is afterwards screwed on, which simultaneously fastens all the segments. It is seen that in this manner the segments are kept rigid even in the absence of mica or other insulating material between them, and, in fact, this insulation would be to no purpose if particles of metallic dust were not liable to establish a contact between the various segments.



FIGS. 1 AND 2.

The insulating material is thus 0·025mm. less than the space separating the segments, which ensures a very close connection between the latter and the grooves. All the segments having exactly the same dimensions, it is not essential to turn the exterior surface of the commutator after they are placed in position.

In case of a section being damaged from any cause, it is an easy matter to take it out and replace it by another without interfering with the remainder, the operation only occupying a few minutes. This arrangement permits of the insulating material having a much greater thickness between the sections on the bushing, as also between the lugs supporting the wires.

In practice, one of the faces of the reserve segments is generally covered beforehand with a sheet of mica; and for an ordinary car motor the fixing of the commutator does not occupy more than half an hour.

Extensions.—Messrs. Easton, Anderson, and Goolden are making further extensions to their new shops at Erith, in order to expedite the carrying out of large contracts.

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MULTIPHASED ALTERNATE-CURRENT SYSTEMS.

The reasons why the two and the three phase systems for the distribution of power and light have not been taken up at all in England are numerous, and no doubt to many engineers conclusive. We believe that local conditions make or mar a system, and attribute the great strides which the multiphase work has made in Germany and Switzerland to the abundant water power available. Without this the two nations in question would, in our opinion, still be greatly hampered in their electrical development by the cost of fuel.

Now, in Great Britain the number of electric supply stations which employ water power can be numbered on the fingers of one hand, and there is no station of any size using water power exclusively. Doubtless, in the more mountainous parts of the kingdom there is still a large amount of water power ready to be harnessed which will in time give scope to the electrical engineer. The question, however, is, Are the English electrical engineers right in ignoring these multiphase systems? Doubtless, some have in the past been misled by the hostile spirit shown by certain technical papers who found the multiphase work easier to damn than to understand. Also, we have suffered from want of practice. The engineers abroad have developed these machines largely by trial and error on successive machines made. From such experiments the single-phase motors have been developed, and we have yet to see a simple explanation of the principle on which these single-phase motors work. So the fact remains that, in spite of the eminent mathematical training which the Germans and Swiss have at their command, it has been the practical men working by rule of thumb who have developed this part of the industry. To return to the argument: the systems have not been developed here because of different local conditions depreciating their value, from which followed a want of interest in, and a consequent want of knowledge of, the capabilities of the subject. To give a bare statement of the facts. The three-phase system *per se* is essentially suitable for power transmission and distribution. It is the most economical, as far as the copper in the line is concerned, of any system used up to the present, and enables motors to be started under load. It is not suitable for lighting without modifications which do away with the economy in the copper of the lines. If lighting is attempted without the modification referred to, which is practically a fourth wire, the fluctuations in the voltage are at times excessive, due to the interconnected arrangement of the circuits in the generator. This difficulty vanishes when the two-phase system is used, with independent line wires for each circuit. Then the voltage of either circuit is independent of the load on the other, so that lamps can be freely used. In fact, the system lends itself to both lighting and power work conjointly. Both the two and three phase alternators and motors can be supplied at prices considerably below that asked for single-phase machines for the same output. There is no doubt but that single-phase motors will come to the fore and be employed

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largely. Up to the present, however, they are all started on the two-phase system. Capacity or resistance in one circuit will give a difference of phase, and at the same time sufficient power current to produce the small starting torque sufficient to start the motor without load. This advantage of being able to start under load is greatly in favour of the duplex system, and we believe that such a system will be exploited in England within reasonable time for some district where there is a fair demand for power. Unfortunately, the backwardness of our engineers in these polyphase systems is unfavourably influencing our export trade. In the colonies and many foreign lands, where we are acknowledged as the makers of the best machinery for general and mining purposes, we are losing caste in the electrical section through want of this branch of our industry, so suitable for long-distance power transmission.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE DUBIAU SYSTEM.

SIR,—You would oblige me by correcting a slight error in your article concerning the Dubiau tubular pump in your issue of July 26. It is there said that this new invention allowed of raising the quantitative efficiency of boilers from 50 to 15 per cent., instead of 50 to 150 per cent., as it should be.—Yours etc.,

Vienna, July 30, 1895. F. ROSS.

REVIEWS.

A Text-Book of Mechanical Engineering. By WILFORD J. LINEHAM. 772 pages. Published by Chapman and Hall, London, at 10s. 6d. net.

Mr. Lineham is the head of the engineering department at the Goldsmiths' Company's Institute at New Cross, and as the outcome of his experience as instructor he has compiled the well-written, well-printed, and well-illustrated book we have before us. It is divided into two parts: (1) workshop practice; (2) theory and examples. In the first part of the book Mr. Lineham makes a tour of the workshops through which a mechanical engineer must pass, hence we have chapters on casting and moulding, pattern-making and casting design, a brief chapter on metallurgy and the properties of metals, other chapters on smithing and forging, machine tools, marking off, machining, fitting and erecting, boiler-making and plate work. In the second part of the book Mr. Lineham deals with theory and examples. The book is illustrated with several hundred diagrammatic examples and 18 plates, which have an actual basis—*i.e.*, they are practical, and founded on practice.

The mathematics employed in this second portion are not of an advanced character. They involve simple equations, fractions, and the use of tables of sines and logarithms. Mr. Lineham has taken a step in the right direction in adopting an uniform synopsis of lettering in his formulæ. The student or reader, therefore, having once grasped the equivalent of a particular letter should avoid the puzzles or pitfalls that attach to varying meanings to particular letters such as may be found in some treatises.

We have not quite made up our mind as to what kind of man the mechanical engineer of the future is likely to be. Most of us who come in contact with the responsible managers of large industrial undertakings have heard laments from time to time of the want of a millwright of the type that flourished up to the seventies. The man of many capacities and ability to manipulate all kinds of hand tools is being converted into a machine-minder.

With the increasing number of machines, with greater and greater diversity of machinery, higher mental capacity will, no doubt, be demanded of the individual labourer. There promises, furthermore, to be a rearrangement of the officials of industrial enterprise, until we shall be classified as either privates, corporals, captains, colonels, or generals of productive industry. Such a book as Mr. Lineham's will serve a useful purpose, whatever view may be taken of the right way to teach or to bring up a mechanical engineer. We take it that those who have thought, or who have formed opinions upon this subject, are agreed that every man should be taught the principles underlying his trade, although there may be differences as to when and where the necessary instruction shall be administered. Mr. Lineham's book serves to give ideas, even where the operations he describes are not practicable in a technical college, as, for example, the process of blocking out a three-throw crankshaft.

The book is somewhat weak on what is perhaps its least important side—viz., metallurgy. It is, however, at least desirable that it should be accurate and not misleading. In the second edition Mr. Lineham should alter a few points that we will briefly indicate. In Chapter I. the pig-iron numbers should run from one to eight, and not in inverse order, as stated. Both the scientific and the commercial practice takes the most open grey pig as No. 1, by which the higher numbers are graded. The opening line on page 2 says "most of the impurities disappear in the blast furnace." As the context deals with pig iron, the statement is inaccurate. What Mr. Lineham doubtless means is that metallic iron is not found in the free state, but that it is freed in the blast furnace from the silicious or argillaceous impurities with which it is combined in the ironstone or iron ore. As a fact, the metallic iron in its molten state picks up impurities in its passage down the blast furnace. It is for this reason that when it emerges from the blast furnace as cast iron or pig iron, it requires after-treatment to fit it for commercial uses.

The "table showing chemical composition of the three principal varieties of pig iron" is misleading. Mr. Lineham should state that pig iron is produced by cold-blast and by hot-blast process of smelting. All chemists are at fault in regard to accounting for the differences in results in after-use between cold-blast pig iron and hot-blast pig iron. In fact, no chemist to-day knows why it is that first-class pig iron produced by cold blast should do certain work which is apparently impossible to pig iron made by hot blast. Chemical analysis fails to account for the differences which are familiar to all practical foundrymen. The making of chilled and grain rolls for rolling mills may be taken as an instance. The making of locomotive engine cylinders from cold-blast pig iron presents another instance familiar to many shrewd observant locomotive engineers.

The analyses quoted by Mr. Lineham are unfortunate, inasmuch as they indicate very bad pig iron for most purposes. The origin of the iron is not stated; from the figures it is apparently common Cleveland iron. Mr. Lineham should expunge these from future editions. If he wishes to give pig-iron analyses, he should quote Nos. 1 2, 3, and 4, mottled and white of a first-class cold-blast pig iron, such as Blaenavon, Farnley, Lilleshall, or Lowmoor, and state the purposes for which each variety or number is recommended. He might then give particulars of some of the best hot-blast foundry iron, such as Nos. 1 and 3 Coltness, Calder, or Gartsherrie, and if he thought well, by way of contrast, analyses of Nos. 1 and 3 Cleveland.

The brief descriptions of the different numbers of ordinary pig iron towards the end of the first chapter are more useful. But Mr. Lineham may add to the value of his book if he briefly gives a description of the influence of the most common metalloids when combined with iron in some more certain way than on page 73.

On page 80 there is a slip in which ingots of mild steel are spoken of as being *piled* and rolled to produce a fibrous steel. Ingots of steel are never piled. This is a feature peculiar to the manufacture of wrought iron from puddled bars. The same paragraph states that if ingots are required for steel castings, they may be "remelted in suitable quantities, etc." If this were physically possible, it is never done, and would be economically disastrous.

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The first chapter of the book dealing with ironfounding illustrates an excellent teaching method. It first describes the melting of the crude iron (pig iron). A sketch in section is given of a cupola; then various examples of open sand, loam, and dry sand moulding are described with plain and appropriate illustrations. The moulding of various typical articles is described, sketches of the moulders' tools are given, and an illustration of a brass-melting furnace also appears.

In the second chapter the art of "pattern-making" is explained in a practical manner. The first chapter has intimated the work to be done. The second chapter proceeds to describe how it should be done. The difficulties attendant upon the crystallisation and warping and shrinkage of castings are explained. From the foundry, where molten metal is cast or poured into moulds, it is appropriate to step into the smithy. Mr. Lineham illustrates different types of smiths' hearths. Sketches are given of different air-blast producing machines, and a large plate shows an arrangement for an engineer's smithy. A series of plain sketches shows the various tools used in the smithy, not only hand tools, but also mechanical appliances, such as a steam-hammer, an "Oliver," and a stamping press. The method of manufacture of various small pieces of smithed work is followed out with sketches of the progress of the work through its various stages.

This is followed by the description and illustrations of the process of making different forgings under the steam-hammer, such as a single-webbed crank, a bell-crank lever, a double-webbed crank, and the manufacture of a bent crank in stamping dies. A coloured plate shows the various temperatures at which steel for various tools should be quenched to obtain appropriate "tempers." In dealing with forge proper, the author describes the manufacture of a large crankshaft under a double standard steam-hammer.

The author then passes on to machine tools. We notice a remark in the opening paragraphs which is characteristic, and to which we call attention, so that it may be corrected or qualified in future editions. Mr. Lineham says, "A thorough knowledge of these machines is necessary, so as to appreciate their capabilities and *enable us to design work to suit them.*" [The italics are ours.] We think the statement undesirable, without qualification. If new work is solely to be designed with a view to its being suitable for existing machine tools, there will be no development either in design or in the making of tools. The construction of the Forth Bridge will illustrate our point. The bridge was designed, but its successful construction was only rendered possible by the after-creation of special tools to get over all kinds of difficulties. A draughtsman engaged in a particular engineering establishment may be invited to arrange his designs to suit the capacities of that particular establishment. But even in this case the manufacturing facilities of a particular establishment may be extended by drawing upon larger works for parts of machinery that are beyond the capacity of a small establishment. This is a matter for discretion based on experience.

In the next edition we hope Mr. Lineham will make clear to his reading pupils that scrap iron is an uncertain and untrustworthy material for wrought-iron forgings, which are better when made from new iron in the Best-Yorkshire faggotted method. Some increase in tenacity may be expected from wrought iron, "especially the shearings of plates from the boiler yard" when "worked over and over again," but this is not explained by a reference to the quality of iron that has been "but once puddled" (page 134). All iron is, strictly speaking, but once puddled. The puddling furnace is an important and valuable apparatus. If the cast iron and the fuel are good and suitable and the puddling has been properly done—that is, if the maximum amount of elimination of impurities from the iron has taken place—then with suitable after-treatment good wrought iron will result. But no amount of after-work will make good iron of material that has not been properly treated in the puddling furnace.

Perhaps the best feature of this book is the admirable examples given of the use of stress and strain diagrams and of graphical methods of solving mechanical problems. These common-sense applications appeal specially to the practical man, and often enable him to avoid unnecessary mathematic, and long calculations. The examples worked out are, as a rule, well chosen, and represent the class of work for which such treatment is wanted in every-day practice. Again, we must commend the most liberal way in which Mr. Lineham has illustrated his book by original sketches of the essential parts of the various machinery and tools described. We should be pleased to see a large amount of space devoted to electrical problems and methods of power transmission. The information given at present is correct but scanty.

In future editions we hope Mr. Lineham will give a leaf-wide margin to the one or two amongst the folding plates that at present cannot be examined as a whole when the book is closed or when some page is under perusal other than that against which the plate appears.

We have examined the book with considerable pleasure. It is one that will prove of value to the young student as well as to the older engineer who has not had the advantage of systematic training in the *technique* of his calling. Carefully revised from time to time, we have no doubt this work will prove a standard text-book on mechanical engineering, for it is worthy of a place on the bookshelf of everyone interested in mechanical engineering.

NIAGARA FALLS AT WORK.

Prof. George Forbes has sent the following letter to the *Times*: "Your New York correspondent lately announced the successful commercial delivery of electric current from the great 50,000-h.p. generating station at Niagara Falls to the first consumers who use it for making aluminium. I also have received reports of the thorough success of the practical working, and it will be interesting to many of your readers to know wherein the novelty of the work consists, and the value of the results to the whole world. When I designed the 5,000-h.p. dynamos the largest in existence were of 1,500 h.p. The transformers which we employ, as well as other machinery, are also of far greater magnitude than any previously made, and this is part of the reason why the cost of these works is far below what any other engineer has been able to approach. There was nothing experimental in going to these large sizes; the nearest approach to experimental work was when I settled upon the machines for converting alternating into continuous current for the aluminium works, and these have now justified my choice. Such machines on a small scale were shown by Schuckert at the Frankfort Exhibition of 1891; but I took upon myself a great responsibility when making the first commercial use of them on so great a scale—four machines, each of 150 volts and 2,000 amperes. I selected as manufacturers the General Electric Company of America, and they deserve the greatest credit for the result. This company has also made some novel and excellent machinery which enables us to supply electrical energy at variable pressure to the 1,100-h.p. electric furnaces of the Carborundum Company. I will not refer to matters which I had to arrange for, but which are not yet completed. These include transmission of electric energy to Buffalo and its distribution; also the machinery for adapting the current for arc lights, for incandescent lights, for electric tramways, and for factories and mills. I mention these only to show the variety of requirements which had to be met, with strict attention to cost. Any customer may now ask either for continuous or alternating current at any fixed electrical pressure, or even at a variable pressure. My solution of the problem lay in (1) the selection of alternating currents, and (2) the reduction of speed of alternations as low as was possible, and (3) additional safety was ensured by my refusal to allow live circuits to be suddenly opened or closed. If this last policy be not continued, the directors will have themselves to blame for trouble which must arise. At the time when I decided upon alternating currents (which had not then been practically used for power purposes), many predicted failure, and some (including my friend Lord Kelvin)

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have continued to do so. Again, when I adopted low frequency it was so generally condemned that I claim some foresight in having recognised its merits. I predicted low cost, high efficiency, and increased safety as the results of low frequency, and in practice I have been altogether confirmed. The price charged (with handsome profit) is half a farthing per Board of Trade unit, for which English companies (under more difficult conditions, it is true) are charging about 6d., and from the time of the inception of this gigantic and novel plant until its commercial working at the present time there has not been a single hitch or mistake to correct. The Niagara Company make a greater profit by not going to great distances, as it costs them less to supply it near at hand. There is no difficulty or experiment in going to great distances; it is merely a question of expense and of the value of power at the place to which it is transmitted. There are plenty of places in the world where it will pay well to carry electrical energy 400 to 500 miles. I have no hesitation in saying that the low cost and perfect success, practically and commercially, of the Niagara works open a new era in the world's industrial evolution."

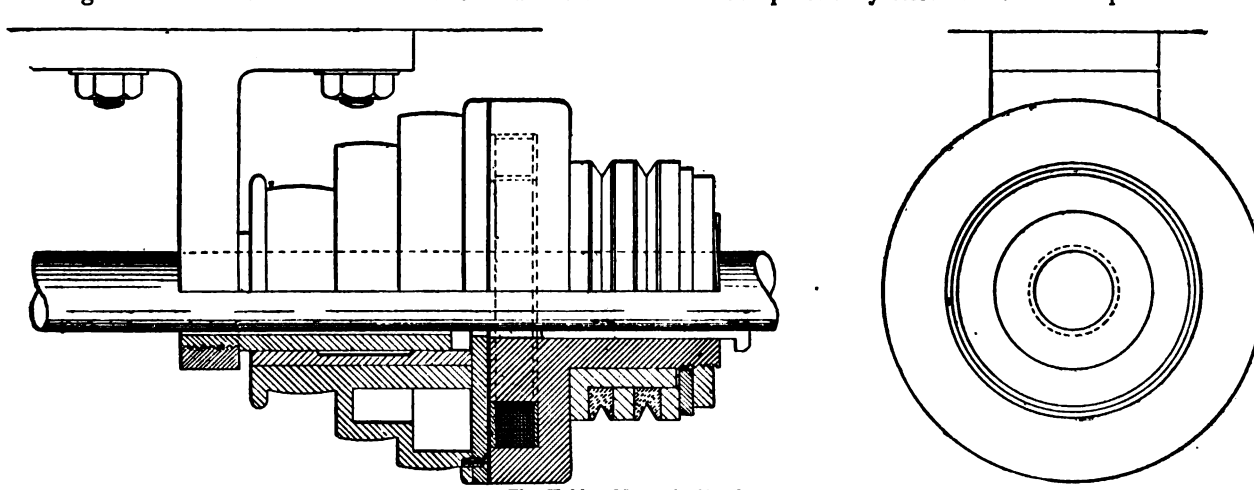
Lord Kelvin has since written as follows: "A letter by Mr. George Forbes in your yesterday's issue contains the following statement: 'At the time when I decided on alternating currents (which had not then been practically used for power purposes) many predicted failure, and some (including my friend Lord Kelvin) have continued to do so.' This is not correct, so far as the inclusion of my name is concerned. It is true that I advised the directors not to adopt the method of alternate currents; and the correctness of my advice is now illustrated by the fact that in the first practical use of the power it has been necessary to transform from alternate current to continuous current for the electrolytic smelting of aluminium. In giving my advice to the directors I told them that they could certainly succeed with alternate current, but much better with continuous current."

To Lord Kelvin Prof. Forbes replies: "If Lord Kelvin were at home, with his documents to refer to, he would not have written the letter published in the *Times* to-day. On looking through his Press copy-book, he will nowhere find that he 'told them' (the Niagara directors) 'that they could certainly succeed with alternate current.' On the contrary, he will find copy of a cablegram, in the summer of 1892, to these directors, declaring my policy of using alternating currents to be a fatal mistake or a disastrous mistake. He will also find the same view supported in a lengthy letter which he wrote at the same date. He will also find that in his letter of November, 1894, he referred to this attempt to save them from disaster. Besides these specific occasions on which he volunteered this advice, he took further action in the same direction at various times. This was embarrassing to the officers of the company, and they did not disregard the advice of an authority so eminent without finding sound reasons to justify their conduct, which I need not mention here. As to Lord Kelvin's suggestion, in the letter published to-day, that it would have been better to distribute to all customers the current required by the Aluminium Company (150-volt continuous current), I can at present only state that it is impracticable, and ask 'how about the 110 volts required for incandescent lighting, the 500 volts required for tramways, the 2,000 volts for arc lights, the 10,000 volts required for transmission to Buffalo, the alternating current required by the carborundum electric furnaces, and so forth?' Nearly everyone will now admit that the alternating current alone solves the problem well and economically."

Prof. Silvanus P. Thompson has also joined in the fray. He says: "Lord Kelvin's prepossession in favour of continuous currents, as against alternating currents, is not supported by modern electrical practice, save for the restricted purposes of electrolytic decomposition. On the contrary, for nine-tenths of all other purposes the advantage is found to lie on the side of alternating currents wherever the distance of transmission exceeds a few hundred yards. Lord Kelvin points to the use at Niagara of a special commuting machine to transform alternating currents to continuous, for a certain electro-metallurgic process, as though the fact that it had been necessary to add this adjunct condemned the use of alternating currents. It proves, however, the precise contrary. All the so-called continuous-current dynamos really generate—as Lord Kelvin knows well without any reminder from me—alternating currents, which are then commuted into continuous currents by a costly mechanical device called a commutator affixed to each machine. It is now recognised by electrical engineers that for nine-tenths of ordinary purposes, such as electric lighting and transmission and distribution of power, it is far better as well as cheaper not to add any commutator. By adding it most of the advantages of alternating currents are simply thrown away, and endless troubles are introduced by the sparks at the commuting brushes, to say nothing of other drawbacks. It would be a great pity if the immense influence of Lord Kelvin's opinion were to be used against progress."

THE HOLDEN MAGNETIC CLUTCH.

This apparatus has been patented by Major Holden, R.A., F.R.S., and Messrs. Drake and Gorham; it is found to be a great convenience at the Woolwich Arsenal, where it has been practically tried for some time past.



The Holden Magnetic Clutch.

Now that the advantages of electrical transmission of power in workshops in place of heavy belting and gearing have been recognised, the use of a magnetic clutch for each of the separate machines is bound to become universal, as it occupies far less space than the cumbersome fast and loose pulley arrangements, and is also less costly. The most economical results are obtained from a motor of fair size, driving a short line of countershaft, from which the machines are driven, in preference to small motors for each machine, which are more expensive in first cost, and necessarily less efficient in conversion of energy. A clutch of the size represented is capable of transmitting at 350 revolutions per minute 3 h.p. in regular work, the expenditure of

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electrical energy being less than 20 watts during the time that the clutch is in action, at other times being nil. Simple forms of switch have been devised for starting and stopping, one form being similar to the arrangement at present in ordinary use with fast and loose pulleys, where pulling one cord starts and the other stops the machine, and another form which is actuated by one cord only, the switch being put on and off by alternate pulls of the cord.

A LABORATORY DYNAMO.

BY PAUL GIRAULT.

Laboratory practice often necessitates the employment of a continuous-current dynamo of high tension and small current. The solution generally adopted is to couple primary batteries or accumulators in series in sufficient number to obtain the voltage desired. This solution is very defective in all respects. The batteries take up a lot of room, are dear, require attention, which is at the same time troublesome and disagreeable, and necessitate minute attention to ensure good insulation; while as regards constancy of the voltage obtained, this is remarkable for its short duration.

On the other hand, a continuous-current dynamo properly worked out appears to fulfil all the required conditions. There is little space required, the price is low, cost of maintenance nothing to speak of, and as regards the voltage at the terminals it is easy to obtain perfect constancy, and to obtain all successive values up to the maximum of the machine by acting upon the speed and on the excitation. On account of these advantages, the laboratory of physical research at the Sorbonne, Paris, have added to their apparatus a high-pressure dynamo capable of giving 0·2 ampere at a pressure of 3,000 volts. This dynamo was ordered by Mr. Hurmuzeseu from the Cail factory in order to continue his researches in the variation of resistance of metallic salt solutions under the influence of high voltages.

Mr. Helmer designed this dynamo, which is illustrated by Figs. 1 and 2, giving a longitudinal and tranverse sections. The illustration only shows one machine, and the set supplied consisted of two such dynamos arranged on the same axis. Thus, in the complete set, four armatures were mounted on the same shaft, each capable of giving 0·2 ampere at 750 volts. Thus by suitable coupling it could supply

0·8	ampere	at	750 volts
0·4	,,	,,	1,500 ,,
0·2	,,	,,	3,000 ,,

These variations are very convenient from a laboratory point of view, and the generating of the pressure in four stages gives security. In case of accidents at least three of the armatures are likely to remain unaffected. The armature cores are built up of sheet-iron discs 12 mils thick, the outside diameter being 9⅞in., and the inside diameter 7⅛in. They are driven on the bronze cylinders by four keys, as shown in Fig. 2, and insulated from each other by paper. The width of the core when finished is 1 9in. The core is then insulated as follows: one winding of cotton tape, one of silk tape, then another of cotton.

The armatures are wound in 160 sections, each of 66 turns. The total number of turns, therefore, is 10,560. The conductor is ·0128in. diameter, and is wound in nine layers carefully insulated with mica. The armature when wound is placed in paraffin and heated up to 150deg. C., and a current is passed through the wires to heat them to ensure the wax getting into all the crevices. In this way a good insulation resistance has been obtained. The commutators are of copper, each having 160 segments, and a diameter of 8in. The method of construction is clearly seen from the diagrams, Figs. 1 and 2.

Magnets.—There are in the complete set two magnetic systems, each energising two armatures. The magnet and pole-pieces are made of soft steel. They are separately excited at 110 volts. There are in all two exciting coils for each magnet, and these are wound with a total of 1,856 turns of ·055in. diameter wire. The diameter of the bore of the poles is 10·6in. Each pole embraces an angle of 165deg. of the armature.

The speed of the machine is 1,500 revolutions per minute, and then about 3,000 ampere-turns are required in the exciting coils. The resistance of each armature is 128 ohms—the copper-resistance loss thus amounting to 3·12 watts. The mean induction in the armature iron is 12,150 C.G.S. lines per square centimetre. The calculated hysteresis loss equals 28·66 watts. That the machine was well able to do its work is shown by the adjoining test figures, when the rated speed was never reached.

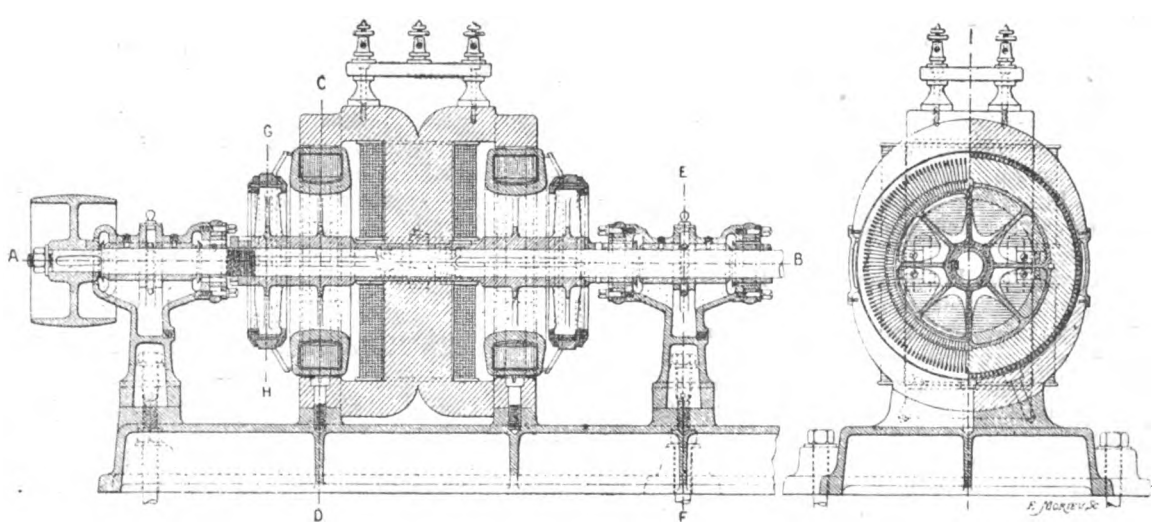

FIG. 1. FIG. 2.

High-Tension Laboratory Dynamo.

Revolutions per minute.	Exciting current. Amperes.	Potential difference. Volts.
1,000	0·9	1,652
960	1 5	2,518
1,061	2 0	3,054
1,028	2·5	3,503
1,040	2 7	3,554
1,087	3·0	3,929

THE MODE OF DEATH FROM ELECTRIC SHOCK.

Dr. J. Mount Bleyer, of New York, has advanced the view that death from electric shock is due to "dynamic apoplexy."

He describes the *post-mortem* appearances in a criminal executed by electricity in whom the bloodvessels of the trunk and limbs were almost empty, while those of the head and neck were distended with blood. The violent muscular contractions produced by electric shock, the *Lancet* says, naturally tend to alter very considerably the distribution of the blood in the various parts of the body, and it is very probable that great cerebral engorgement, with hæmorrhages into the brain substance, may commonly occur

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in death from electric shock. The medical man who made the necropsy, however, would seem to overstate the case when he says that two quarts of blood escaped when the skull was opened. There is not room in the cranial cavity for that quantity. The immediate cause of death from electric shock is almost certainly due to stoppage of the heart, the injury to the brain here described not being an essential factor, though it may frequently coexist as a complication.

ELECTRIC LIGHTING PROVISIONAL ORDERS.

BOARD OF TRADE REPORT.

We give below the report by the Board of Trade respecting the applications to and proceedings of the Board of Trade under the Electric Lighting Acts, 1882 to 1890, during the past year. The following is a list of the applications for provisional orders since the date of the last report (see *Electrical Engineer*, August 24, 1894), together with the title of order and description of area, the names of promoters, and how dealt with by the Board of Trade:

Alderley Edge Electric Lighting Order.—The Urban District of Alderley Edge.—The Urban District Council.—Order granted.

Bath Electric Lighting Order.—The City of Bath.—City of Bath Electric Lighting and Engineering Company, Limited.—The promoters failed to produce the consent of the local authority, and the Board of Trade directed that a local enquiry should be held. After consideration of the report made by the inspector appointed to hold the enquiry, the Board of Trade were of opinion that no reasons had been advanced sufficient to justify them in dispensing with the consent of the local authority, and refused to grant the order.

Bootle Corporation Electric Lighting Order.—The Borough of Bootle.—The Corporation.—Order granted.

Brechin Electric Lighting Order.—The Royal Burgh of Brechin—Scottish House-to-House Electricity Company, Limited.—The local authority consented to the grant of the order, subject to certain agreed conditions as to purchase, and the profits of the undertaking. The latter condition the Board of Trade was unable to sanction, and, as the local authority refused to modify the conditions, the promoters did not proceed with the application.

Carlisle Corporation Electric Lighting Order.—The City and Municipal Borough of Carlisle.—The Corporation.—Order granted.

Leigh Urban Sanitary Authority Electric Lighting Order.—The Urban Sanitary District of Leigh.—The Local Board.—Order granted.

Liverpool Electric Lighting Order.—Portions of the City of Liverpool and of the Local Government District of Toxteth Park.—Liverpool Electric Supply Company, Limited.—The Liverpool Corporation consented to the grant of the order; but the Toxteth Park District Council refused their consent. The Board of Trade, however, for the reasons stated in the special report made by them and presented to Parliament, decided to grant the order.

Llandudno Electric Lighting Order.—The Urban Sanitary District of Llandudno.—The Urban District Council.—Order granted.

Luton Corporation Electric Lighting Order.—The Borough of Luton.—The Corporation.—Order granted.

Margate Electric Lighting Order.—The Municipal Borough of Margate.—Municipal Electric Light and Power Corporation, Limited.—The promoters failed to produce the consent of the local authority, or to satisfy the Board of Trade that it should be dispensed with, and the Board of Trade refused to grant the order.

Montrose Electric Lighting Order.—The Royal Burgh of Montrose.—Scottish House-to-House Electricity Company, Limited. The local authority consented to the grant of the order, subject to certain agreed conditions as to purchase and the profits of the undertaking. The latter condition the Board of Trade was unable to sanction, and as the local authority refused to modify the conditions, the promoters did not proceed with the application.

Motherwell Electric Lighting Order.—The Burgh of Motherwell. The Commissioners of the Burgh.—Order granted.

New Windsor Corporation Electric Lighting Order.—The Borough of New Windsor and the Eton Urban District.—The Corporation of New Windsor.—Order granted.

Prescot, Huyton and Roby, Rainhill, Eccleston, and Whiston Electric Lighting Order.—The District of the Prescot Local Board; the District of the Huyton and Roby Local Board; the Townships of Rainhill Whiston, and Eccleston.—British Insulated Wire Company, Limited.—Order granted for the Urban District of Prescot. As regards the other districts included in the application, the promoters failed to produce the consent of the local authorities, or to satisfy the Board of Trade that it should be dispensed with, and the Board decided to exclude those districts from the order.

Radcliffe Electric Lighting Order.—The Urban Sanitary District of Radcliffe.—The Urban District Council.—Order granted.

Stirling Electric Lighting Order.—The Parliamentary Burgh of Stirling.—The Commissioners of the Burgh.—Order granted.

Pontypool Electric Lighting Order.—The District of the Pontypool Local Government.—Pontypool Electric Light and Power Company, Limited.—Order granted.

Salisbury Electric Lighting Order.—The City of Salisbury.—Salisbury Electric Light and Supply Company, Limited.—Order granted.

Southampton Electric Lighting Order.—The County Borough of Southampton.—Southampton Electric Light and Power Company, Limited—Order granted.

Swindon New Town Electric Lighting Order.—The Urban Sanitary District of Swindon New Town.—The Local Board.—Order granted.

Walthamstow Electric Lighting Order.—The Local Government District of Walthamstow.—The Local Board.—Order granted.

Winchester Electric Lighting Order.—The City of Winchester.—The Corporation.—Order granted.

Windermere and District Electric Lighting Order.—The Districts of the Urban Sanitary Authorities for Grasmere, Ambleside, Bo'ness, Windermere, and Kendal; the District of the Kendal Union Rural Sanitary Authority; the Districts of the Urban Sanitary Authorities for Ulverston and Grange; the District of the Ulverston Union Rural Sanitary Authority; a Portion of the District of the Lancaster Union Rural Sanitary Authority.—Windermere and District Electricity Supply Company, Limited.—The promoters failed to produce the consent of the local authorities for Ambleside and Kendal, or to satisfy the Board of Trade that it should be dispensed with, and the Board of Trade omitted those districts from the order as granted. The Ulverston Urban District Council, the Ulverston Rural District Council, and the Grange Urban District Council pressed for an amendment of the purchase clause of the order, but the Board of Trade were unable to sanction the amendment, for the reasons stated in the special report made by them and presented to Parliament.

Worthing Electric Lighting Order.—The Borough and District of Worthing.—The Corporation.—Order granted.

THE COUNTY OF LONDON.

Battersea Electric Lighting Order.—The Parish of St. Mary, Battersea.—County of London and Brush Provincial Electric Lighting Company, Limited.—The promoters failed to produce the consent of the local authority, or to satisfy the Board of Trade that it should be dispensed with, and the Board of Trade refused to grant the order.

Newington Electric Lighting Order.—The Parish of St. Mary, Newington.—Same promoters.—Same result.

Notting Hill Electric Lighting Order.—A portion of the Parish of St. Mary Abbotts, Kensington.—Notting Hill Electric Lighting Company, Limited.—Order granted.

St. Olave Electric Lighting Order.—The District of the St. Olave District Board of Works.—County of London and Brush Provincial Electric Lighting Company, Limited.—Order granted.

Strand District Electric Lighting Order.—The District of the Strand District Board of Works.—Charing Cross and Strand Electricity Supply Corporation, Limited.—The local authority consented to the grant of the order, subject to certain modifications in its terms. The Board of Trade were unable to accept some of these modifications, but for the reasons stated in the special report made by them and presented to Parliament, they decided to grant the order.

Of these applications (29 in number) 14 were made by local authorities and 15 by companies. Five of the applications related to London.

Licenses.—The following application for a license has been received since the date of the last report, and has been dealt with in the following manner: The Salisbury Electric Light and Supply Company, Limited.—The City of Salisbury.—License granted December 6, 1894.

Of applications for licenses referred to in previous reports, that of the British Insulated Wire Company, Limited, was granted on October 8, 1894.

Appended to the report is a list of the provisional orders confirmed by Parliament (prior to the present session) and of the licenses granted by the Board of Trade since the passing of the Electric Lighting Act, 1882, showing those which have since been revoked or repealed.

LEGAL INTELLIGENCE.

WOODHOUSE AND RAWSON.

In the action Wood *v.* Woodhouse and Rawson, United, Limited, before Mr. Justice Vaughan Williams, on Wednesday,

Mr. Wright, for the official receiver and liquidator, said there was a summons by him asking leave to be given to institute proceedings, under Section 10 of the Companies Winding-up Act, against the directors and auditors, and that the costs be provided for by the receiver in the action out of the assets in his hands. The application came before this Court on May 16, and his lordship then directed that meetings of the debenture-holders should be held to ascertain their wishes with reference to taking proceedings. The opinion of counsel had been taken, and it was to the effect that the dividend declared in 1891 was to a very large extent paid out of capital, and that no less than £20,000 was recoverable in respect of that dividend, while other sums might also be recovered. The total debenture debt ranking for dividend was £160,000. Of that amount there were £65,500 first mortgage

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debentures with 6 per cent. interest, £83,000 second debentures bearing 5½ per cent. interest, and £14,000 bearing 10 per cent. interest, the last being a specific charge on certain securities. Out the assets, other than those that could be realised by instituting proceedings, the receiver estimated that the 6 per cent. debentures would get 6s. 8d. in the £, or a deficiency in their security of £43,700. The 5½ per cent. debentures would get nothing, so that there was a deficiency of £83,000, and the 10 per cents., who had the specific charge, would get 17s. in the £. At the meeting 29 holders of the 6 per cents. (representing £36,300) were present, and nine, holding £3,900, voting in favour of instituting proceedings, and 20, holding £32,400, voted against. The 10 per cent debenture-holders voted unanimously against taking proceedings. At the meeting of the 5½ per cents. 50 were present, representing £34,423 out of £83,000. Fourteen, holding £8,421, were in favour of, and 36, holding £26,000, against taking proceedings. The position the official receiver took was that it was a debenture-holders' question, that they were entitled to the assets, and that there was nothing for the shareholders; but it was somewhat singular that the debenture-holders should have taken up this attitude.

His Lordship: I generally find that debenture-holders with security are against proceedings. Do you say they honestly voted that there should be no proceedings?

Mr. Macnaghten said he appeared only for the plaintiffs in the action, and he could not enter into their minds on this question. But the official receiver was chairman, and that was a guarantee that the meetings were properly conducted.

His Lordship: They may have come to the conclusion they did either because, notwithstanding counsel's opinion, they thought there was no good cause of action, or they may have thought it was too risky, and therefore not worth spending money upon, or they may have thought that those from whom the sums of money were to be recovered were not worth powder and shot.

Mr. Macnaghten said his client, who was at the meeting, instructed him that all these views were expressed.

His Lordship said he would assume, then, that they acted from such motives as they had suggested, and they all came under the same category. They did not want proceedings; but if the unsecured creditors thought fit to realise those assets it would not hurt the debenture-holders one bit, and, therefore, he expected them to assent to it. If they did not, he would feel bound to take the conclusion they had come to as one not arrived at in good faith.

Mr. Macnaghten said that the only point was whether proceedings should be taken at the expense of the debenture-holders.

His Lordship said he would take the opportunity of testing their good faith.

Mr. Macnaghten: And do you call a meeting of these people?

His Lordship directed that there should be a meeting of all three classes of debenture-holders at one time to know whether those who would not take proceedings would abandon their claim to any assets recovered in proceedings instituted by others, the official receiver to take the chair, and this summons to stand over until the result of the meeting was reported to the Court.

PRESCOT ELECTRIC LIGHTING.

On Monday, in the Queen's Bench Divisional Court, Mr. Baron Pollock and Mr. Justice Wright heard the case of the British Insulated Wire Company, Limited, *v.* the Prescot Urban District Council. It was a special case, which raised the short point as to whether a contract was void or not as construed by the light of the one hundred and seventy-fourth section of the Public Health Act, Sub-section 2. Mr. Lawson Walton, Q.C., M.P., and Mr. R. N. Arkle appeared for the plaintiffs, and Mr. Otto Danckwertz for the defendants.

Mr. Arkle said the question for decision was whether that contract between the parties was void by reason of its not containing a pecuniary penalty in respect of the non-performance of any of its conditions. The contract was made in November, 1892, and it was provided that the company should efficiently light the streets within the district of the Local Board by means of electricity for a period of five years from January 1, 1893 The lamps were to be stationed in the streets as approved by the Local Board, and were to be laid down and kept in repair at the expense of the company. One-half the incandescent lamps should be lit during the hours of darkness all the year round, the other half to be lit from dusk to midnight from August 25 to May 25 in each year, and the arc lamps were to be lit from dusk to midnight, no notice being taken by the company of moonlight or other causes which would tend to enable them to depart from a fixed course of electric lighting. The Local Board were to pay £350 per year, payable quarterly, in consideration of such lighting, and the company was to indemnify the Local Board in respect of all actions in regard to the works and the light. The action was brought to recover £78, which included three quarterly payments of £87 respectively, and the balance was made up of three sums for extra lamps. The contract was duly executed, and the seal of the Board affixed. These facts were agreed, and the only point between the parties was whether the absence of a penalty clause in the contract vitiated the contract. Learned counsel's submission was that the clause in the Act regarding this was merely directory, and did not vitiate the contract. The point had never been decided before, though it had been raised twice.

Without calling upon Mr. Danckwertz to reply,

Baron Pollock said he did not see how the Legislature intended that the question of penalty should be treated as a merely voluntary matter. Sub-section 2 was not merely directory, as it specified that a penalty should be stated in the case of the contract not being performed.

Mr. Justice Wright concurred.

Judgment was thereupon entered for the defendants with costs.

COMPANIES' MEETINGS AND REPORTS.

ELECTRICAL POWER STORAGE COMPANY, LIMITED.

The sixth ordinary general meeting of this Company was held at 4, Great Winchester street, E.C., yesterday, Mr. John Irving Courtenay in the chair.

The **Chairman** said he was glad to meet the shareholders again and to be able to say that the directors recommended the same dividend as last year—viz., 5 per cent. They had also been able to increase the reserve fund by the sum of £2,684. 12s. 11d., so that that account now stood at the satisfactory figure of £12,000. A larger sum than usual had been spent at Millwall in plant and tools—viz., £1,696. 10s. 8d.—which included new boilers, engine, and building extensions. The directors had reduced the selling prices of the Company's storage batteries. They fully appreciated the exertions of the manager (Mr. Frank King) and his staff, who had by their unremitting attention to maintaining the high quality of the Company's batteries, and at the same time reducing the cost of manufacture, enabled the directors to meet the severe competition in this most practical and telling manner. He concluded by moving the adoption of the report and accounts.

Sir Daniel Cooper, Bart., G.C.M.G., seconded the resolution, which was carried unanimously.

Mr. James Pender, M.P., was re-elected a director of the Company, and the auditors, Messrs. Meston and Co., were also re-elected.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

The annual general meeting of the shareholders of this Company was held on Monday at the Cannon-street Hotel, under the presidency of the chairman, Mr. James Staats Forbes.

The **Chairman**, in moving the adoption of the report and accounts, which were printed in our last issue, said that they now had the results of the second year of Company's working since the expiry of their patents. That expiry took place at the end of the first three months of the preceding year, when they were immediately subjected, as they had fully expected, to rather severe competition from a great many quarters, including their German friends, who were pretty astute and persevering. The shareholders would have to extend to the directors and managers of their properties their confidence, and believe that their daily knowledge of the circumstances of the business would enable them, with prudence and discretion, to secure the interests of the proprietors without putting on them the necessity of making public in too great detail the many items which made up the business. He need scarcely tell them that during the time of the protection of their patents they were in a very advantageous position, being enabled, as they were, to fix their own prices. As the period approached for the expiry of the patents they made prudent arrangements for meeting the severe competition which was likely to arise, and that those arrangements were effectual was proved by the results of the following nine months, when they were able to pay to the shareholders a reasonable dividend. In the second year following the accentuation of the competition they had to face a very considerable reduction in the prices of the articles they produced, but the satisfactory feature of that year seemed to be that notwithstanding the severity of the competition they were able to show a larger volume of output. They had sold more lamps during the year than in the preceding year; but inasmuch as during three months of the preceding year their prices continued high, owing to the non-expiration of their patents, the money results were altered, but, being altered, they still left such a margin of profit as made the payment of a 5 per cent. dividend for the year perfectly easy, rational, and wise. They began the year with stock on hand to the value of £87 768, and at the end of the year that stock had increased to £95,983. The wages, purchases, etc., had amounted to £85,112. Notwithstanding the very severe competition, notwithstanding that natural desire which prudent people had to substitute a cheaper article for a dearer one, they had been able to maintain their business, to improve their character, and to learn a good deal. They now knew a good deal more accurately than before the wants of the public, with the result that the volume of their business had increased, and if the receipts had diminished slightly as a consequence of prices having fallen, the quantity had increased.

The **Earl of Lichfield** seconded the motion, which was carried.

The **Chairman** moved: "That a dividend be, and is hereby, declared on the 'A' shares of the Company of 1s. 6d. per share on the 89,261 ordinary shares, £3 paid; of 2s. 6d. per share on the 5,000 £5 fully-paid shares allotted to the Edison Electric Light Company, Limited; and of 2s. 6d. per share on the 12,139 £5 fully-paid shares allotted to the Swan United Electric Light Company, Limited; being, together with the interim dividend paid on March 20, 1895, 5 per cent. in respect of the year ended June 30, 1835. All to be distributed in accordance with the provisions of Clause 87 of the articles of association, less income tax."

This was seconded and carried.

The retiring directors (the Earl of Lichfield and Mr. Ernest

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Villiers) were reappointed, as were also the auditors (Messrs. Welton, Jones, and Co.).

An extraordinary general meeting followed for the purpose of considering the following special resolution, of which formal notice had been given: "Resolved that the articles of association of the Company be altered by striking out Article 87 and substituting therefor the following article: '87. The amount from time to time declared by the Board as available for dividend, including the amount, if any, recommended by them to be withdrawn from reserve for equalisation of dividends shall be applied as follows: (1) There shall be first set aside thereout a sum equal to a preferential cumulative dividend of 7 per cent. per annum on the aggregate amount for the time being paid or credited as paid on the 'A' shares. (2) Out of the sum so set aside there shall be paid a preferential cumulative dividend at the rate of 5 per cent. per annum on the amounts paid or credited as paid on the 'A' shares without distinction. (3) Subject thereto, there shall be paid out of the sum so set aside a further cumulative dividend at the rate of 2 per cent. per annum on the amount paid or credited as paid on the 'A' shares, provided that until all the 'A' shares be fully paid, no 'A' share, whether fully paid or not, shall, for the purpose of this sub-section, be deemed to have paid up on it more than the amount paid up or called up upon the 'A' shares for the time being having the least amount called up or paid thereon. (4) The balance of the sum so directed to be set aside shall be carried to the reserve fund. (5) The residue of the amount declared to be available for dividend after setting aside the sum mentioned in Sub-section 1 shall be applied in payment of dividends *pari passu* on the accounts paid up or credited as paid on the 'A' and 'B' shares, but so that for the purposes of this sub-section the amounts to be deemed paid up on the 'A' shares shall be ascertained as in the case of Sub-section 3.'"

The resolution was carried on the motion of the **Chairman**, seconded by the **Earl of Lichfield**.

CITY AND SOUTH LONDON RAILWAY COMPANY.

The twenty-second ordinary general meeting of this Company was held on Monday at Winchester House, E.C., Mr. Charles G. Mott presiding.

The **Chairman**, in moving the adoption of the report, stated that although they were able to recommend a slightly increased dividend, the result of the working of the past half-year had been somewhat disappointing. They began the period very well, the traffic showing a steady and regular increase, and they had hoped that at the end of the half-year they would have a very satisfactory report to present. As soon, however, as the fine weather set in at the end of March their traffic began to fall off, with the result that at the end of the six months very little of the improvement remained which they had in the first part of the period under review. All the railways, however, or nearly all of them, had from one cause or another shown a heavy decrease in the last six months, and most of them were reporting decreased dividends. The receipts from passenger traffic, other than season-ticket holders, showed a decrease of £335 last half-year compared with those of the June half of 1894, but there had been an increase in the receipts from season tickets of £482. Their expenses exhibited a net increase of £29. The increase of £106 in passenger duty was owing to the advance they made in their fares from Stockwell, but these fares had now been reduced again, and they were no longer liable for passenger duty on them. The balance carried to net revenue account was £9,381, to which £47 for interest and £950 brought forward had to be added. After paying their debenture interest (£3 959) and the preference dividend (£1,912) they were enabled to recommend a dividend on the ordinary stock at the rate of 1½ per cent. per annum, leaving a balance of £964 to be carried forward. The working expenses had been 61·5 per cent. of the receipts against 61·69 per cent. in the June half of 1894, and if they took off the cost of the lifts, as they generally did, the amount was about 52 per cent. This was a fairly low rate of working, but they hoped to get it very much lower. The locomotive expenses per train mile had been 6·10d. in the past half-year against 6·22d., and if they deducted, as they had done before, the carriage of coal, the expense per train mile came out at about 4¾d. The receipt per train mile had risen from 2s. 1¼d. to 2s. 2½d. this half-year, owing to the increased fares charged. The receipts per passenger had also risen from 1·61d. to 1·82d. They had carried during the half-year, exclusive of season-ticket holders, 3,113,000 passengers, showing a decrease of 270,000 as compared with the number conveyed in the corresponding period of 1894, but this had been compensated for to some extent by the higher fares and the increase in the receipts from the season-ticket holders. The falling off in the number of passengers was no doubt partly owing to the increased fares charged, and partly to the extraordinarily fine weather in the last three months of the half-year. Their experience of the motor-car train which was running at the date of their last meeting had been satisfactory so far as it went, but it had not made them very anxious to convert the rest of their stock. It would be a very expensive operation, and would take a long time, and there were various reasons why they thought it should not be carried out at present. The most important of these reasons was that at the last meeting they determined that they should go on with the extension as far as Finsbury-circus. When that extension was completed they would be able to run heavier trains, carrying very many more passengers, and probably they would endeavour to run these trains more rapidly than they did at present. All this would require very much more powerful motors, and they thought it better to postpone any further proceedings in this direction until the extension was completed. Their engineer had at last devised a plan by which he could convert the King William-street Station into almost a replica of the Stockwell Station, having a centre platform and two lines of rails on each side, so that they would be able to work three or four trains per hour more into it than they could at present. This would give them about 25 per cent. additional accommodation. They were endeavouring in every way they could to reduce their expenditure. They were now running two engines to drive the dynamos which worked the line, but there were times in the middle of the day and on Sundays when a great deal of the power produced was wasted, and they had ordered a smaller engine and dynamo to work in conjunction with one of the larger engines and dynamos at slack times when the power of the two large engines was not required. This would diminish the cost of working to some extent. They were also proposing to run an additional number of two-coach trains during the quieter hours of the day and on Sundays and to purchase additional coaches for that purpose. They had done something towards improving the lighting of the carriages in the past half-year, but it was not yet satisfactory. They were going to make other experiments with the view of still further improving the illumination of the trains. The plans for the extension to Finsbury circus had at length been devised by Mr. Greathead, and they were now in negotiation for the sites of the stations. The Bill for extending the time for the Clapham extension had received the Royal assent, and this would give them another three years for completing that portion of their undertaking.

Mr. Sampson Hanbury seconded the motion.

The **Chairman** said, in reply to an enquiry, that an extension to Moorgate-street Station was in contemplation.

The report was then unanimously carried, as was also a vote of thanks to the chairman.

NATIONAL TELEPHONE COMPANY, LIMITED.

The ordinary general meeting of the above Company was held at Cannon street Hotel on Friday last, Mr. J. Staats-Forbes occupying the chair.

The **Chairman**, in moving the adoption of the report, stated that the increase in the income of the past half-year, to June 30, was £33,963, as compared with the income of the corresponding period of 1894. The working expenses also showed a considerable increase, but not much out of proportion to their larger business. The net result, after deducting £35,263 for the Post Office royalties, was a profit balance of £151,703, or an increase of £11,169 over the balance shown a year previously. The rentals carried forward for unexpired terms of running contracts amounted to £390,978, or £45,619 in excess of the amount shown at the corresponding period of 1894. They proposed to pay the usual dividends on the first, second, and third preference shares, less income tax, and 5 per cent. on their ordinary shares, free of income tax. They proposed to carry to the reserve fund £35,000 out of the balance then remaining, and this would leave £3,288 to be carried forward. For the first time their net income had been arrived at after charging interest out of revenue upon their large reserve fund. If the shareholders approved the directors' recommendation, the reserve fund would in their next balance-sheet stand at £314,500. The work of metallic-circuiting London had been going on quietly now for some time, and at great cost, but happily it was approaching completion. He regretted that the change had caused a great derangement in their machinery from time to time, to the serious annoyance of many of their subscribers. This, however, had been unavoidable. The example of Berlin was often held up to them, but he knew Berlin very well. Everything was regulated there, and the people knew how to wait their turn when they desired to use the telephone. Every subscriber in London, however, thought that he had the fee-simple of the whole apparatus at his command—that he alone had to be served. Reference was made in the report to the formal agreement with the Post Office for the acquisition by the Department of the company's trunk lines. They had bowed to the inevitable, and made the best terms they could, and he believed that they would prove to be extremely good terms if the Government and the Post Office authorities were as loyal as the Company. There was not the slightest reason to doubt that they would be, and he ventured to say that, for the revenue of the country, for the efficiency of the telephone service, for the public interest, and for the interests of the Company, it would be the best combination that could have been made, because the Post Office were enabled to take risks in connection with the extension of the system which the Company would not be inclined to take, but of which they would have the benefit, while they would themselves be left free to develop what was their more special business—the conduct of the exchange work in the great areas. The heads of the agreement with the Post Office were signed more than two years ago, but they had been necessarily subjected to a great deal of discussion. In virtue of the agreement, the Company had made considerable sacrifices, for he had no doubt that if they had been allowed to go on under the old arrangement they would have made a more substantial advance in the development of the telephone system. The agreement, with the Company's consent, after being laid on the table of the House of Commons, was eventually referred to a special committee, who sat for a considerable time and met on several occasions. He believed that everything that could be alleged against the Company was brought against them before the committee, but the Company's turn came, and then they gave the facts, the figures, and the arguments on their side. Owing

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to the dissolution of Parliament the committee's labours came to a close, and in their report they had recommended that a committee on the same subject should be appointed next session "to consider and report upon the evidence already taken, and, if necessary, to take further evidence." Out of the 15 members who sat on the committee 10 or 11 had been re-elected members of Parliament, and he only hoped that the enquiry would be finished speedily, because until then they would not know where they were.

The motion was passed.

The Right Hon. Lord Harris, G.C.S.I. G.C.I.E., has been elected a director and vice-president to fill the vacancy caused by the resignation of the Right Hon. the Lord Balfour of Burleigh; and Sir Henry George Calcraft, K.C.B., has been elected a director to fill the vacancy caused by the resignation of Colonel R. Raynsford Jackson.

ANGLO-AMERICAN TELEGRAPH COMPANY, LIMITED.

The ordinary half-yearly meeting of the shareholders of this Company was held on Friday last at Winchester House, under the presidency of the Marquis of Tweeddale (chairman of the Company).

The **Chairman**, in moving the adoption of the report and statement of accounts, said that for three half-years he had had to deplore a falling off of traffic receipts, the decrease in July last having been £16,791, while in January of the present year it was £6,948. On this occasion, however, he was happy to be enabled to report that there was an increase of £9,382, which, although not a very large addition to the gross income of the Company, was, at any rate, a step in the right direction. It was also an indication of a welcome return to confidence in business circles, which probably meant a much greater increase in the future. This prospect had certainly been confirmed by the receipts of the current month, which showed the largest increase over the months of the preceding year that had been received in the course of the present year. It was, however, disappointing that the whole of the half-year's increase was not available for dividend. This was in consequence of the repairing ship "Minia" not having been enabled to earn as much as she did during the corresponding period of last year. The decreased earnings thus accounted for amounted to £2,550. On the other hand, the expenditure showed one or two satisfactory features, there being a decrease of £1,342 under the head of repairs of cable, though, on the other hand, there was an increase of £1,009 under the head of expenses at stations and at the head office, which brought the net decrease to £333. This, however, though apparently a small sum, was significant when it was remembered that the decrease under this head last year was no less than £4,460, it being very satisfactory that that large amount should have been decreased still further. The directors had, before declaring the net profits, set aside the sum of £12,000 for the renewal fund, leaving a balance of £74,331. One important matter was the condition of the company's cables, and he was glad to be enabled to state that they were in first-rate working order. The new cable was in as good a condition as it was expected to be in with regard to its power of transmission, while the cables of 1873 and 1874 were also in excellent electrical condition. The same statement might be made with regard to the 1880 cable. There was, he was glad to say, a slight increase in the dividend to be declared, but although it was only slight he thought that as the Company had had a good many lean years they were now entitled to look forward to something better in the future. The French case was still *sub judice*, but the directors, under the advice of eminent counsel, have entered an appeal which they believed afforded a reasonable prospect of a successful issue.

Mr. F. A. Bevan seconded the motion, which was agreed to.

GLOBE TELEGRAPH AND TRUST COMPANY, LIMITED.

The twenty-second annual meeting of the shareholders of this Company was held on Friday last at Winchester House, the Marquis of Tweeddale occupying the chair.

The **Chairman**, in moving the adoption of the report, said that the receipts of the Company for the past year, with the small balance carried forward, were £179,992, out of which had been distributed £123,361 in interim dividends. The directors now recommended the payment of a final dividend on the preference and ordinary shares, making altogether a total dividend of 6 per cent. upon the former shares, and 4⅛ per cent., against 4½ last year, upon the latter. There was a decrease in the receipts of £5,611, which was attributable to three causes: in the first place, there was a smaller dividend received from the Anglo-American Telegraph Company in the first two quarters of the current year; in the second place, a smaller return from their investments in the Direct United States Cable Company; and there was the paying off of the Direct Spanish Company's 6 per cent. debentures. Looking at the depression that had been prevailing during the last few years in commercial circles, he considered the distribution to be a fair one. Referring to the Company's investments, he pointed out the increasing market value of their shares, and stated that while the paid-up capital was £3,602,690, the value to-day stood at £4,296,395, showing the very handsome surplus of £793,000. He thought the shareholders would agree that this was very satisfactory.

Lord Sackville A. Cecil seconded the motion, which was agreed to.

Sir J. Pender and Mr. Brodrick were re-elected directors.

CHILI TELEPHONE COMPANY, LIMITED.

The annual general meeting of this Company was held on Tuesday at Winchester House, Mr. Geo. Keith occupying the chair.

The **Chairman** said the shareholders would see with satisfaction that, despite the adverse circumstances that had prevailed in Chili during the year, the Company had done fairly well, and they were able to declare a dividend of 2½ per cent. per annum. A small addition to the tariff had caused 704 of their old subscribers to withdraw, but they had been replaced by 676 new ones, while at the same time the Company had opened up new ground in country districts. The gross receipts had improved by about 10 per cent., and the net profits had been £6,013, as compared with £3,528 last year. The rate of exchange was gradually becoming more favourable for the Company, and in that respect their prospects were much brighter, the result of the Conversion Bill and the adoption by Chili of a gold standard. He moved the adoption of the report and accounts, and the motion was seconded by **Mr. Frank W. Jones** and carried.

GULCHER (NEW) ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

An extraordinary general meeting of this Company was held at 73, Lombard-street, E.C., on Monday for the purpose of receiving the first annual report of Mr. Charles Fitch Kemp, the voluntary liquidator to the concern, which was published in our last issue. Representatives of the Press were not admitted to the meeting.

RAND CENTRAL ELECTRICAL WORKS, LIMITED.

The statutory general meeting of the above Company was held on Wednesday at Winchester House, Old Broad-street, E.C., Sir Charles Rivers Wilson occupying the chair.

The **Chairman** said that the Board, which was properly constituted, had every expectation that the hopes held out when the Company was formed would be amply realised. The contractors had arranged to complete their portion of the work within 18 months from May 3 of this year—that is to say, they would hand over all the appliances not later than November 3, 1896. Messrs. Price, Waterhouse, and Co. were appointed the auditors of the Company.

LIVERPOOL OVERHEAD RAILWAY COMPANY.

Report of the directors and abstract of accounts for the half-year ending June 30, 1895, to be submitted to the fourteenth half-yearly general meeting of the shareholders to be held at the Law Association Rooms, 14, Cook-street, Liverpool, on Tuesday, August 13, 1895, at 3 p m.:

Directors: Sir William Bower Forwood, J.P., Ramleh, Blundellsands (chairman); James Barrow, Esq, J.P., 7, Beach Lawn, Waterloo; John Brancker, Esq, J.P., Green Bank, Wavertree; Harold Brocklebank, Esq., 20, Bixteth-street, Liverpool; Richard Hobson, Esq., J.P., 54, Brown's-buildings, Liverpool; Edward Lawrence, Esq., J.P., 5, Fenwick-street, Liverpool; George H. Robertson, Esq., F 24, Exchange-buildings, Liverpool. Engineer and manager: S. B. Cottrell, Esq., M.I.C.E., 31, James-street, Liverpool Secretary: William H. Alexander, Esq., C.A., 24, North John-street, Liverpool.

In presenting the half-yearly statement of capital and revenue accounts to June 30, 1895, the directors have to report that the gross revenue receipts amount to £28,143. 3s. 1d., and the working expenses to £18,653. 18s. 1d. The number of passengers carried since the opening of the railway being as follows:

	Half-year ending Dec. 31, 1893.	Half-year ending June 30, 1894.	Half-year ending Dec. 31, 1894.	Half-year ending June 30, 1895.
First class	260,221	277,653	362,179	400,260
Second class	1,293,840	1,246,975	2,228,224	2,114,462
Workmen (special return tickets)..	921,578	1,336,809	1,050,976	945,338
Total.....	2,475,639	2,861,437	3,641,379	3,460,060

These figures show a continued and satisfactory increase in the traffic. The contracts for the southern extension have been let, and the works will be commenced without delay. In order to meet the necessary expenditure, your directors have decided to offer to the shareholders at par, on application, the unissued portion of the ordinary capital.

Revenue Account.

Receipts from passenger traffic amount to	£27,708	6	1
Miscellaneous receipts	434	17	0
	£28,143	3	1
Less working expenses	18,653	18	1
	£9,489	5	0
Deduct interest on mortgage debenture	2,500	0	0
	£6,989	5	0
Add balance brought forward, December 31, 1894	1,087	12	5
Leaving available for dividend.....	£8,076	17	5

Out of this balance your directors recommend the declaration of dividends at the following rates (less income tax), payable on

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and after August 17—viz., 5 per cent per annum on preference shares, £2,529. 0s. 9d.; 2½ per cent. per annum on ordinary shares, £4,244. 17s. 9d.—leaving a balance of £1,302. 18s. 11d. to be carried forward to next half-year.

REVENUE ACCOUNT, HALF-YEAR ENDED JUNE 30, 1895.

Half-year ended June 30, 1894.	Expenditure.	£ s. d.
£1,870 1 5	Maintenance of way, works, and stations (Abstract A)	2,897 9 5
3,179 11 6	Locomotive power (Abstract B)	4,525 14 5
425 2 6	Repairs and renewals of carriages (Abstract C)	275 10 0
6,276 1 7	Traffic expenses (Abstract D)	7,003 6 4
1,403 5 3	General charges (Abstract E)	2,064 14 10
289 4 10	Law charges	520 10 1
5 0 0	Compensation	6 2 0
1,399 9 1	Rents, rates, and taxes	1,304 1 1
99 9 4	Government duty	56 9 11
£14,947 5 6		£18,653 18 1
5,064 9 4	Balance carried to net revenue account	9,428 3 1
£20,011 14 10		£28,082 1 2

Half-year ended June 30, 1894.	Receipts.	£ s. d.
£19,658 13 11	Passenger traffic	27,708 6 1
3 5 3	Parcels, etc.	10 14 0
328 0 8	Rents	336 1 1
21 15 0	Transfer fees	27 0 0
£20,011 14 10		£28,082 1 2

Abstract A.—Maintenance of Way, Works, etc.

Half-year ended June 30, 1894.		£ s. d.
£19 10 0	Salaries, office expenses, and general superintendence	8 19 7
309 2 11	Wages	510 5 3
130 1 7	Material	266 4 8
359 15 5	Repairs of structure and opening bridges	568 5 8
426 11 6	Repairs of stations and buildings	518 14 3
625 0 0	Provision for renewal of boilers, machinery at generating station, permanent way, etc.	1,025 0 0
£1,870 1 5		£2,897 9 5

Abstract B.—Locomotive Power.

Half-year ended June 30, 1894.	Running expenses—	£ s. d.
£1,975 9 7	Wages connected with the working of generating engines and motors	2,488 16 2
896 9 10	Coal and coke	870 7 10
149 19 0	Oil, tallow, and other stores	107 13 0
157 13 1	Repairs and renewals—wages	407 2 6
—	Materials	651 14 11
£3,179 11 6		£4,525 14 5

Abstract C.—Repairs and Renewals of Carriages.

Half-year ended June 30, 1894.		£ s. d.
£282 2 8	Wages	138 0 10
142 19 10	Materials	137 9 2
£425 2 6		£275 10 0

Half-year ended June 30, 1894.	Abstract D.—Traffic Expenses.	£ s. d
£4,681 9 4	Salaries and wages, etc.	4,925 2 10
969 2 7	Fuel, lighting, signalling, water, and general stores	1,350 7 9
255 14 3	Clothing	358 6 1
369 15 5	Printing, stationery, and tickets	369 9 8
£6,276 1 7		£7,003 6 4

Half year ended June 30, 1894.	Abstract E.—General Charges.	£ s. d.
£350 0 0	Directors	350 0 0
52 10 0	Auditors	52 10 0
678 3 9	Salaries of secretary, general manager, and clerks	717 2 11
181 3 4	Office expenses of ditto	218 12 2
17 10 0	Advertising	81 7 5
103 11 11	Insurance	114 17 9
20 6 3	Travelling expenses	30 4 7
—	Liverpool Tramways and Omnibus Company	500 0 0
£1,403 5 3		£2,064 14 10

Dr. GENERAL BALANCE SHEET, JUNE 30, 1895.	£ s. d.
Capital account, balance at credit thereof	14,871 11 0
Net revenue account, balance at credit thereof	8,076 17 5
Interest payable or accruing, and provided for	2,426 15 2
Sundry outstanding accounts	3,739 8 11
Renewal fund	3,300 0 0
	£32,414 12 6

Cr.	£ s. d.
Cash in bank (current account) and in hand	26,812 2 11
Parliamentary deposit on extension railways authorised by Liverpool Overhead Railway Act, 1892, and interest thereon	4,092 5 5
Stock of stores and stationery	1,118 8 9
Sundry outstanding accounts	391 15 5
	£32,414 12 6

DIRECT UNITED STATES CABLE COMPANY.

The ordinary general meeting of the Direct United States Cable Company was held on Tuesday, Sir John Pender occupying the chair.

The **Chairman** said that the depression in the United States had resulted in their being able to pay only 2 per cent., instead of 5 per cent. as in former times. The Company was in a very sound position, and he hoped for a return of their former prosperity. The report was adopted.

THOMAS PARKER, LIMITED.

The report of this Company for the year ending April states that the Company was formed in 1894, but only commenced work as a manufacturing concern about the end of January last. By far the larger portion of the management and working expenses, staff salaries, etc., having been incurred in the development of the business, planning, designing, and erection of the buildings and plant, the preparation of loose tools, patterns, etc, the directors might have charged a very considerable proportion of these expenses to plant, etc., but have preferred to charge them all to a general account, the balance of which is £4,143. The directors propose to transfer £3,000 of this amount to the goodwill and development account, and to treat the balance, £1,143, as preliminary expenses, to be dealt with in future accounts. Many important contracts and orders have been already secured, and the trading prospects for the year are such as to give the directors the fullest satisfaction.

LEIPZIG TRAMWAYS COMPANY, LIMITED.

The directors of the Leipzig Tramways Company, in their report for the financial year ended June 30 last, state that the total receipts for the year were £109,934, compared with £105,449 in the previous year, and the total expenses were £78,779, against £77,048, the profit being £31,155, against £28,401. The cost of working is thus 71·68 per cent. of the receipts, as against 73·07 per cent. in the previous year. Owing to the very long and severe winter the expenses for the maintenance of the permanent way, and for the renewal of horses, have been materially increased, otherwise the working expenses would have again shown a reduction this year, notwithstanding the small increase in the car mileage. In accordance with the resolution passed at the extraordinary general meeting of the shareholders held on April 1 last, the directors have entered into an agreement with the Gesellschaft für Elektrische Unternehmungen for the transfer of the undertaking to a German company with a view to working the tramways by electricity. This agreement, they are informed, has been approved by the municipal authorities of Leipzig, and has now to receive the sanction of the Government. After providing for debenture interest, the interim dividend, and all other charges, there remains a balance of £9,314, out of which the directors have placed £2,000 to the credit of the reserve fund, and now recommend the payment of a dividend of 4½ per cent. for the six months on the ordinary and preference shares, which will make, with the interim dividend paid in February last, a dividend of 7½ per cent. for the year on both preference and ordinary shares. The dividends will absorb £7,110, leaving £204 to be carried forward.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ille-sur-Tet.—La Mairie d'Ille-sur-Tet, Pyrénées-Orientales invites tenders by August 11 for the concession of the electric lighting of the town.

Brighton.—The Corporation invite tenders by August 10 for the supply and erection at the electricity works, North-road, of evaporative brass-tube surface condensers, electrically-driven air-pumps, exhaust and condenser piping. Specifications can be obtained from the town clerk.

King Cross (Halifax).—Tenders are invited for the electric lighting of the King Cross Constitutional Club. The building can be inspected between 9 a.m. and 5 p.m. on application to the steward. Tenders to be in by 5 p.m. on August 5, addressed to the chairman of the House Committee.

Aylesbury.—Tenders are invited for lighting the public lamps and clock tower within the district for one year from September 1, for the Aylesbury Local Board. The conditions for lighting and all other particulars in connection therewith may be obtained on application to Mr. George Fell, clerk, Aylesbury, to whom tenders must be sent by August 9.

Cowes.—Tenders are invited by the Urban District Council for laying down an electrical plant of sufficient capacity to keep

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burning at the same time 2,200 8-c.p. lamps, and also for public lighting and the laying of mains to accommodate 3,000 lights at the same time. The length of the road to be lighted is about a mile. Particulars can be obtained from Mr. Nelson F. Dennis, A.M.I.C.E. engineer to the Council, Cowes. Tenders are to be delivered by August 27.

Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

Edinburgh.—The Town Council are prepared to receive tenders for the supply of (1) insulated concentric cable for high-pressure alternating current; (2) for transformers. Specifications can be obtained from the resident electrical engineer, 5, Dewar-place, Edinburgh, on payment of a deposit of one guinea, which will be returned on receipt of bona fide tender. Sealed tenders are to be lodged with the town clerk not later than 10 a.m. on Friday, August 9, 1895, endorsed "Tender for Concentric Cable" and "Tender for Transformers."

Leicester.—Tenders are invited by the Gas and Electric Lighting Committee of the Town Council for the manufacture, delivery, and erection of a cast-iron water-tank, to be placed upon a tower at the Aylestone road works. Drawings may be seen and specification and form of tender obtained upon application to Mr. Alfred Colson, M.I.C.E., engineer, Millstone-lane, Leicester, and on payment of £5, which will be returned on receipt of a bona fide tender. Tenders, addressed to Alderman Lennard, chairman, endorsed "Tender for Water-tank," to be delivered by 11 a.m. on August 10.

Romford.—The Romford Urban District Council invite tenders for lighting the public lamps in the town of Romford, as to about 190 of such lamps from sunset to sunrise, during 12 months from September 1. Tenders to include the cost of lighting, cleaning, and repairing, and are to be sent to Mr. Geo. Bailey, clerk, Romford, by 4 p.m on August 6. A contract and (if necessary) a bond with sufficient sureties will have to be entered into and given by the person or persons whose tender may be accepted. Further particulars may be had on application to the surveyor. No special forms of tender.

London, W.—The Hammersmith Vestry invite tenders for complete schemes for public and private lighting, and for the supply of motor power in that portion of the parish of Hammersmith described in the provisional order as the compulsory area. Memoranda of instructions, with a map of the district, may be obtained from Mr. H. Mair, surveyor to the Vestry, on or after July 10, 1895, between the hours of nine and five, Saturdays nine and one, on payment of a deposit of £10, which will be returned to persons sending in a bona fide tender. Tenders are to be delivered at the meeting of the Vestry, at the Vestry Hall, at 6.30 p.m. on September 4.

Wakefield.—The Corporation invite tenders for the supply and erection of the following: Section A—boiler house plant (boilers and fittings, mechanical stokers and engine economiser, feed-pump, injector, etc.); Section B—engine-house plant (steam alternators, condensers, oil filter, fittings, etc, steam, exhaust, feed, blow-off, and sundry pipes, valves, and water-tank, etc.); Section C—main switchboard and instruments; Section D—underground work (cables, junction-boxes, culverts, and trenching, etc.); Section E—sub-station fittings (transformers and switchboard, etc.); Section F—arc lamps and posts; Section G—meters; and Section H—overhead crane. Particulars are obtainable from Mr. Robert Hammond, Ormond House, Great Trinity-lane, E.C., on and after August 2 on payment of £2. 2s, which will be returned on receipt of a bona fide tender. Tenders are to be delivered by August 24.

London, W.C.—Tenders are invited for the erection of a laboratory in Clement's-lane, London, W.C., for the Commissioners of H.M Works and Public Buildings. The site can be inspected by appointment with the clerk of works at the Patent Office Extensions, Took's-court, Cursitor-street, E.C., between 2 and 4 p.m. Drawings, specification, and a copy of the conditions and form of contract may be seen on application to Mr. Taylor, 12, Whitehall-place, S.W., between 11 a.m. and 1 p.m. Bills of quantities have been prepared for the use of builders by Messrs. Welch and Atkinson, 10, Lancaster place, Strand, and, together with forms of tender, may be obtained at H.M Office of Works, 12, Whitehall-place, S.W., on payment of £1. 1s. The sums so paid will be returned to those persons who send in tenders in conformity with conditions specified. Tenders are to be delivered before 12 noon on August 7, addressed to the Secretary, H.M. Office of Works, etc., 12, Whitehall-place, London, S.W., and endorsed "Tender for Laboratory."

RESULTS OF TENDERS.

London W.—The following tenders have been received for the electric lighting of St. James' Club (part of). Mr. W. Howard Tasker, M.I.E.E., 12, Pembroke-road, Kensington, W., is the consulting engineer:

Crompton and Co.	£573.	10	0
Clarke and Co.	536	6	0
Drake and Gorham	518	18	0
Moody Bros.	475	5	0
Belshaw and Co. (accepted)	467	14	9
Verity and Sons	432	10	0

Dewsbury.—The following is the list of firms who tendered for the Dewsbury Pioneers Industrial Society's electrical installation:

Electroliers included.

Electrical and Mechanical Supply Company, Leeds	£1,580	0	0
Lowcock, Hill, and Co., Manchester	1,250	0	0
J. A Edmondson, Leeds	1,185	5	1
S. Z. Waring and Son, Manchester	1,075	0	0
Rhodes and Webster, Bradford	990	0	0
Paterson and Cooper, London	932	0	0
Thorp and Waring, London	900	0	0
C. A. Parsons, Newcastle	865	0	0
Graham, Chapman, and Co., Morley	829	15	0
Bennet and Druce, Preston	739	0	0
Nunns and Sykes, Halifax	735	0	0
Electrical and General Engineering Company, London,	720	0	0
A. R Turner, Dewsbury	713	10	0
Ullathorne and Hartley, Bradford	709	7	0
Crompton and Co., Limited, London	915	0	0
G. A. Steinthall, Bradford (accepted conditionally)	730	0	0
H. F. Joel and Co., London	952	17	0
Maunsell, Mercier, and Co., Manchester	727	0	0
A. Sykes, Huddersfield	667	10	0

Electroliers not included.

A. Hirst and Son, Dewsbury	777	0	0
Manchester Edison-Swan Company, Limited	743	0	0
Sharp and Kent, London	616	0	0
B. Verity and Son, Manchester	610	0	0

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,109.

Rand Central Electric Works, Limited.—The offices have been removed from Warnford-court, E.C., to 120, Bishopsgate-street Within.

City of London Electric Lighting Company, Limited.—Warrants for the interim dividend on the 6 per cent. preference shares have been posted.

Westminster.—It is stated that the annual gas bill of the Houses of Parliament is £3,000, the bill for electric light £1,800, and, in addition to the gas and electric light, the use of oil-lamps costs £1,250.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 28th ult. amounted to £1,197, as compared with £933 in the corresponding week of last year, being an increase of £264.

Hackney.—The Vestry have decided to introduce the electric light in conjunction with a dust destructor. The scheme has been entrusted to Mr. Francis Hastings Medhurst, the consulting electrical engineer.

Folkestone.—A meeting of the Town Council has been held at which Mr. Medhurst's bill for £55. 18s. 1d. for professional services was, on the motion of Mr. Pursey, seconded by Mr. Thompson, referred to a committee.

St. James and Pall Mall Electric Light Company, Limited.—The share transfer books will be closed till August 7, preparatory to the payment of an interim dividend on the ordinary and preference shares for the half-year ending June 30.

Church-Lighting.—The Tayler Smith Electric Company have just been entrusted with the installation of the electric light in St. Mary's, Aldermanbury, E.C. Some 200 lights of varying candle-power will be employed. The work is to be carried out at once.

Venezuela Telephone and Electrical Appliances Company, Limited.—Coupon No. 10 of the 5 per cent. first mortgage debentures, due July 31, will be paid from that date at the Consolidated Bank, Threadneedle street, E.C., or at Messrs. Westendorp and Co.'s bank, Amsterdam.

Light Railways, Tramways, and Cable Transport Syndicate, Limited.—This Company has been registered, with a capital of £10,000 in £1 shares, to construct, maintain, and work any railways, light railways, roadways, tramways, or cableways in the United Kingdom or elsewhere.

Harrogate.—Mr. Geo. Wilkinson, M.I.E.E., has been appointed to advise on the lighting of the new Montpellier Baths, which are being erected by the Corporation at a cost of £75,000. The current will be obtained from the Corporation electricity works, which Mr. Wilkinson has also in hand.

Bromley (Kent). — At the District Council's last meeting a letter was read asking the Council to assist a syndicate which had been formed to introduce electric lighting in Bromley, the provisional order having lapsed. The letter was referred to the Standing Orders Committee.

Barmouth.—Notice has been received by the Urban District Council that the Barmouth and District Electric Lighting and Power Company intend applying next session for a provisional order for public and private lighting. Mr. Thos. Blackburn, C.E., of Barmouth, is the engineer for the scheme.

Douglas (Isle of Man).—The chairman and directors of the London and North-Western and Lancashire and Yorkshire Railway Companies arrived at Douglas on Monday last by the steamer "Duke of Lancaster," and inspected the Douglas and Laxey Electric Tramway and the Snaefell Mountain Railway.

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Telegraphy in India.—The Director-General of Telegraphs, says *Indian Engineering*, has been instructed to arrange for the construction of a telegraph line from Bezwada to Ennore before September 1 next, by which time the Royapuram-Ennore section of the Bezwada-Madras Railway should be opened for traffic.

City and South London Railway.—The returns for the week ending July 28 were £827, compared with £858 for the corresponding period of 1894, being a decrease of £31. The total receipts for the half-year 1895 are £3,421, as compared with £3,458 for the corresponding period of 1894, being a decrease of £37.

Automatic Electric Sign Company, Limited.—This Company has been registered, with a capital of £5,000, to enter into two agreements, dated June 15, with G. F. Kenyon, to acquire any patents or inventions capable of being used in connection with the supply of electricity, and to develop and turn to account the same.

Charing Cross and Strand Electricity Supply.—The directors of the Charing Cross and Strand Electricity Supply Corporation, Limited, have declared an interim dividend for the half-year ending June, 1895, at the rate of 4 per cent. per annum on the ordinary share capital of the Corporation (£150,000), and carried forward £2,870.

New Phonophore Telephone Company, Limited.—This Company has been registered, with a capital of £10,000, to enter into an agreement with the Phonophore Company, Limited; to acquire any patents, patent rights, etc., relating to improvements in telegraphic, telephonic, etc., apparatus, and to develop, work, and generally turn to account the same.

Helios Arc Lamps.—We have received from the International Electric Company, 55, Redcross-street, Barbican, E.C., a copy of their new edition of the Helios arc lamp list, which gives details of the construction, use, and management of the same, with numerous illustrations. There is also a list of the electric light supply stations in this country in connection with which these arc lamps are used.

Electric Ozone Syndicate, Limited.—This Company has been registered, with a capital of £12,000, to enter into certain agreements for the acquisition, by purchase or otherwise, of certain patents relating to improved means of generating and dealing with ozone by means of electricity, and to develop and turn to account the same; as mechanical engineers, etc. Registered without articles of association.

Blackpool.—The quarterly meeting of the librarians of the Mersey district was held at Blackpool on Friday last, when representatives from the libraries at Liverpool, Birkenhead, Leigh, Blackburn, Fleetwood, and other places were present. Set papers were dispensed with owing to an accumulation of questions for discussion, these comprising points in the electric lighting of libraries, ventilation, etc.

Poplar.—The District Board of Works have held a meeting, at which a communication was received from the Board of Trade to the effect that in the circumstances referred to by the Board they were prepared to defer the consideration of the question of the revocation of the electric lighting order for a year from the present date. Mr. Bussey: I suppose we will get another year after that. The Clerk (Mr. Wm. Farnfield): I suppose so.

Launch-Lighting.—The anniversary dinner of the Royal Windermere Yacht Club took place at the hotel adjoining the yacht club on Saturday last. A large assembly collected to witness the fireworks got up by the yacht club. Another feature of the illuminations was the electric launch "Lady May," which was most tastefully decorated by means of several 16-c.p. 100-volt lamps, the same being controlled by the lever switch that worked the motor.

Dover.—At the Town Council's last meeting the surveyor reported that the notice of laying electric light mains in Maison Dieu-road, etc., was an extension of the system beyond the original scheme. There would be several transformer chambers put in. He recommended the approval of the application. A plan with the position of the arc lamps in Snargate-street was received from the company and referred to the Pier and Town Wards Lighting Committee.

Fire Brigade Alarms.—At Tuesday's meeting of the London County Council, the Fire Brigade Committee recommended that the seal of the Council be affixed to agreements (in duplicate) with the Post Office in respect of telephonic communication between the Mile End station and the Burdett-road street station, and between the Holborn station and the Strand street station, and to agreements in respect of two fire-alarms in Ancona-road, Islington, and Broughton-road, Fulham, respectively.

St. George's (Hanover-square).—At the last meeting of the Vestry the Joint Vestry Hall Committee presented a report recommending that the Board-room and the offices be fitted with electric light, at a cost of £150 each to the Guardians and Vestry. Mr. Bromwich, while not hostile to the use of the electric light, thought they should wait until they had all the figures before them, and he moved the adjournment of the question for that purpose. After some discussion this was agreed to.

Partnership.—Mr. R. Booth, of 110, Cannon-street, E.C., has taken into partnership Mr. H. W. Ravenshaw, A.M.I.C.E. Mr. Ravenshaw for the past 11 years has been chief of the electrical staff of the firm of Messrs. W. T. Goolden and Co., whose business is now merged with that of Messrs Easton and Anderson, Limited, of Erith, and Mr. Ravenshaw's services have been retained by this firm as consulting electrical engineer. Mr. Ravenshaw has been identified for many years with the transmission of motive power by electricity, and has carried out some of the leading installations as well as central-station and general electric lighting.

Whitechapel.—A meeting of the District Board has been held, at which, upon the question of a notification that an electric lighting company was about to apply for a provisional order to light the Whitechapel district, Mr. Catmur moved: "That it is undesirable that the electric lighting of the district should be in the hands of a private company, and that the notice from the Capital and Counties Electricity Supply Company should be referred to the Streets Committee for consideration and report." This was agreed to.

Alderley Edge.—The monthly meeting of the District Council was held on Monday night, when a letter was read from Mr. S. V. Clirehugh, electrical engineer, Manchester, stating that he had been requested to ask the Alderley Council if they were prepared to dispose of the electric lighting provisional order which had recently been granted to them. After discussion it was decided that the clerk should reply that the Council were prepared to dispose of the order on an adequate payment being made, and on an undertaking being given that the lighting should be carried out in accordance with the views of the Council.

Birkenhead.—A local paper says: "The District Council have before them for consideration a scheme for lighting the place by electricity. A firm of electrical engineers have offered to lay down plant for the purpose which will cost the Council no more than £500 a year, the sum now being paid for gas. The power will be obtained from one of the newly-invented wind motors, which will be erected at Hilbre Point near the red rocks, and the firm are so confident of success that they offer to lay down the plant and give a supply for six months, and if not satisfactory they will remove it at their own cost and make no charge for the supply."

Barry.—The directors of the Barry Railway Company are about to make arrangements whereby the whole of their passenger trains will be lighted by means of electricity. With this object in view a new first and second class coach, specially fitted with electric appliances of the most improved type, was put on the line one evening last week for test purposes, and the new arrangement fulfilled in the most satisfactory degree its requirements. The supply for the coaches will be entirely independent of each other. The experiment having proved admirably successful in every detail, it is expected the whole of the passenger service on the Barry railways will be lighted by means of electricity.

New Mains in London.—The Notting Hill Electric Lighting Company intend to lay mains and to construct street boxes in and across Addison-road and in Bedford-gardens. The House-to-House Electric Light Supply Company will lay high and low tension mains across Richmond-road. The Hampstead Vestry will lay mains in Goldsmith-place, Springfield gardens, Alexandra-road, Avenue-road, Upper Avenue-road, Kidderpore-avenue, North End-road, alongside Hampstead Heath, Heath-street, Finchley-road, Hampstead-hill-gardens and Belsize-park-gardens. They will also construct a sub-station at the corner of Alexandra-road and Abbey-road. The London County Council have approved of these works.

Copper.—Under Wednesday's date, Messrs. Lewis Lazarus and Sons report: Copper was again very strong in New York and purchases of American copper were made here for reshipment. Meanwhile the advance here moves slowly, to-day's gain being only 5s. per ton. On first 'Change 800 tons were taken at £45. 7s. 6d. and 8s 9d. cash; £45. 10s. and 11s. 3d. for late August dates; £45 12 6d. and 13s. 9d. for September; £45. 15s., 17s. 6d., and 16s 3d. three months. Fully 700 tons more were done on second 'Change, prices moving from £45. 10s. to 12s. 6d. for August dates; £45. 16s. 3d. to £46 three months. Closing values £45. 12s. 6d. cash; £46 three months; settlement price £45. 10s.

Lighting Corporation, Limited.—This Company has been registered, with a capital of £250,000, to maintain and uphold any appliances, apparatus, or plant requisite for gas, electric, oil, or any other methods of lighting now in vogue, and to carry on, in all their respective branches, the businesses of manufacturers of and dealers in incandescent lights and other apparatus for increasing the illuminating power of gas, spirits, oil, or other light and heat producing agents, suppliers of light, heat, electricity, and motive power; as electricians, gas engineers, gas workers and fitters, manufacturing, analytical, and general chemists, chemical manufacturers, mechanical engineers, and ironmongers.

Glasgow.—The Electric Lighting Committee of the Town Council have held a meeting, at which it was stated that the gross revenue for the year had been £21,196 11s. 4d., and the gross expenditure, including depreciation, £17,138 18s. 9d., leaving a balance to be carried to profit and loss account of £4 057. 12s. 7d. Out of this the committee have paid £5 000 on interest, loans, and sinking fund, leaving a deficiency of £1,500, which is transferred to the gas account. The committee recommend that the price of the current be continued at 6d. per Board of Trade unit, and they anticipate that, with the increased consumption, next year will be a more prosperous one. They began the year with 208 more customers than last year.

Bradford.—A special meeting of the Gas and Electricity Supply Committee of the Bradford Town Council was held on Monday to appoint, subject to the approval of the Council, a successor to Mr. S. W. Baynes as electrical engineer at the Corporation electricity works. Mr. Baynes sent in his resignation a little while ago in order to take up an appointment in London. The number of applicants for the position which he has resigned was 58, and three of these gentlemen had interviews with the committee on Monday. The result was that Mr. Alfred H. Gibbings, A.I.E.E., who for the past two years has filled the post of electrical engineer

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to the Hull Corporation, was selected for the appointment at a salary to begin with of £300 a year. Mr. Gibbings is 29 years of age and had experience at Brighton before entering the service of the Hull Corporation.

Devonport.—At the last meeting of the Town Council the town clerk read letters from two electric lighting companies notifying their intention of applying for powers to supply Devonport with electric light. At a subsequent stage of the meeting the Highways and Streets Committee reported that Mr. Paris, representing the London Brush and Provincial Electric Light Company, attended before them, and explained the objects of the company applying to the Board of Trade for a provisional order, and the terms under which they would be prepared to hand over the property to the Corporation in a stated period. The Town Clerk advised the Council to proceed cautiously. It was his opinion that the Council should obtain its own provisional order, and afterwards make arrangements with some electric lighting company. After some discussion Mr. T. W. Martin moved and Mr. Ryder seconded that the matter be referred back to the Streets Committee to report upon. This was agreed to.

Instruments.—Messrs. Evershed and Vignoles, Limited, electrical engineers, Woodfield Works, Harrow-road, W., have purchased from Messrs. Easton, Anderson, and Goolden, Limited, the instrument business founded by Messrs. Goolden and Trotter in 1886. They state that they will endeavour to maintain the reputation established by their predecessors by making careful design, and workmanship of the highest class, essential features of every instrument, from the cheapest gauge to the most costly standard which they produce. The whole of the Evershed patents having passed into their hands, they will continue to make the various instruments associated with that name, including the Richards-Evershed system of electrical ship's telegraphs now being introduced into the Navy and they have therefore retained the services of the whole of the technical staff, who have had many years' experience of this work. No change is contemplated in the general scope of the business, but they will, as occasion offers, take up the manufacture of such electrical and kindred apparatus as may meet the special requirements of the engineering industry.

Islington.—At the last meeting of the Vestry the Vestry Clerk said the Electric Lighting Committee had met that evening, and reported that they had considered the question of the advisability of a public opening of the central electric lighting station, and were of opinion that such an opening would conduce to the success of the electric lighting undertaking in the parish by bringing the attention of the public thereto; and they recommended that a memorial be prepared and presented to his Royal Highness the Prince of Wales, with a view to his performing the opening ceremony in November next. Mr. Lambert moved: "That a petition be presented, under the seal of the Vestry, to his Royal Highness." Mr. Street seconded. The motion was agreed to. On a question of referring accounts to the Finance Committee for payment, Mr. Bryen asked why a sum of £3 had been incurred to make the electrical engineer a member of the electrical section of the London Chamber of Commerce. Mr. Lambert: To enable Mr. Gay to represent us at the Chamber of Commerce. Mr Gay agreed to pay the money himself, but we thought he should not do that. The accounts were passed.

Fulham.—The Electric Lighting Committee of the Vestry have held a special meeting with respect to the proposed installation of the electric light in the parish in connection with a dust destructor. Mr. Threlfal moved that the clerk should be instructed before any further steps were taken in the matter to request the various parishes of London and other places in which the electric light had been installed, whether by their parish authorities or by companies, to furnish the Fulham Vestry with the best information they could upon the number of shops and other places of business within the area of supply and the number taking the light, the number of houses and the number taking the light, with the ratable value of the houses and shops supplied; the length of roads; the system of gas lighting in use, and its cost previous to the introduction of the electric light; and the amount charged to the parish for the lighting by electricity, and the number and kind used. Mr. Threlfal said the lights for St. Pancras cost each £46 per annum, while the cost of gas was £3. One electric light was equal to 4½ gas lamps, so that they had a cost of £46 compared to £13. 10s. in electricity and gas. The whole of the electric lighting cost £4,000, or nearly as much as Fulham paid for the whole of the gas for the parish. Mr. Comben said that out of 18 municipalities now using electricity 16 were making a profit—10 of them as much as 3½ per cent—and of 28 private companies only two or three showed a loss. The motion of Mr. Threlfal was carried.

Toxteth.—On Saturday, at the invitation of the Urban District Council of Toxteth Park, a large number of gentlemen interested in sanitation inspected the new destructor works and depôt constructed by that Council at Richmond Lodge, Smithdown-lane. There are six cells or furnaces erected back to back, with a main flue to carry off the gases placed between, on the Fryer principle, as improved by the manufacturers, Messrs. Manlove, Alliott, and Fryer. The gases pass from the main flue through a Jones cremator, which is maintained at a temperature of over 1,000 F., which is found to be sufficient to destroy all noxious gases produced in the cremation of house refuse. From the cremator the gases pass through a large multitubular boiler, 12ft. in length and 7ft. in diameter, or through a by-pass flue, and then through the screen chamber to the chimney, which has a height of 185ft. 6in from the top of the concrete foundations, and is 5ft. 6in. in diameter. The steam is used for driving a small engine which works the firebars to the cells and supplies steam for the engine at the depôt, besides an engine which drives a dynamo providing electric light for the destructor works and the approach roads. The electrical installation has been erected to the specification and under the supervision of Mr. W. G. P. Macmuldrow, electrical inspector to the Corporation of Liverpool. The Council have executed with their own staff work to the extent of £1,170 5s 9d. out of a total expenditure of £7.888 8s. 5d. in excavating site, making embanked approaches, constructing roads, sewers, and all concrete work in foundations and floors The remainder of the work was carried out by various contractors as follows: retaining walls, Messrs. Kelly Bros., Walton, £290. 7s.; chimney, Messrs. Holden and Myles, Stalybridge, £1.001. 14s; buildings, Mr. John Webster, Wavertree, £1,107. 13s. 3d.; destructor furnaces cremator, boiler, screens, etc., Messrs. Manlove and Co., Nottingham, £4,080. 18s 5d.; and electric installation, £237. 10s.

Liverpool.—A meeting of the Special Lighting Committee of the City Council was held this week at the Municipal Offices. The chairman's report as to the recent negotiations, which have resulted in the purchase by the Corporation of the undertaking of the Liverpool Electric Supply for a sum of about £400,000, was considered and put into its final form. The committee thereupon approved of it, and it will be circulated as soon as it is printed for the information of the Council and of the general public. A special meeting of the City Council has been summoned for Wednesday, September 4, to consider, and if thought expedient to approve of, the intention to make application, and of such application to the Board of Trade by the Mayor, aldermen and citizens of the city of Liverpool, acting by the Council of the city, and being the local authority of the city, for the purposes of the Electric Lighting Acts, 1882 and 1888, for a provisional order to supply electricity, for public and private purposes, under the provisions of the Acts, within the area of the city of Liverpool, as the same may exist at the time of granting the said order.—The Howe Electrical Engineering Company, of Liverpool, have lately carried out some extensive work in and near Liverpool, having had a large installation at Thornton Hall, near Neston, Cheshire, and several small installations. They have just installed complete at the Paddington Theatre of Varieties, Edge-hill, in that city, an engine, dynamo, 580 16-c.p. lamps, and six arc lamps. The engine is driven by gas, and is one of Messrs. Crossley Bros.' latest type, having only one flywheel, weighing nearly four tons, with a third bearing. The dynamo was made by Messrs. Laurence, Scott, and Co., Limited, Norwich, for whom the Howe Electrical Engineering Company are sole agents in Liverpool and district, and is a machine capable of working at full load at 240 amperes at 110 volts. The switchboard and distribution boards have been specially designed by the Howe Electrical Engineering Company to meet the requirements of the theatre, and it is possible to change the colour and control the lights on the battens, flies, footlights, stage, and in the house from any section, and to graduate them from full intensity down to absolute extinction.

Bristol.—One of the smartest things in the way of rapid tramway laying ever done in this country, says a Bristol paper, has been the reconstruction of the line of rails from the end of West-street to St. George's Church (the present terminus) by the Bristol Tramway Company, in connection with their four miles of route for the electric tram service between Bristol and Kingswood. The distance between the end of West street and St. George is two miles, but with the large portion of double line the actual run of single line laid has been three miles, and this work has been done in six weeks, or at the rate of a mile a fortnight. The company, after abandoning their first intention of adapting the old line with its T rails and chairs, which might not have been heavy enough to wear well under the strain of the weight of the electric cars, determined about two months ago to lay down a new line with girder rails, and a heavier form of construction, uniform with the new section in course of construction from St. George to Kingswood. They were, however, at once faced with the difficulty of accomplishing this additional work in time to open the whole line at the end of August. At this stage they sought the assistance of Mr. J. C. Robinson, C.E., upon whose report they had already acted in connection with the whole electrical scheme. Mr. Robinson, who has had considerable experience in work of this kind in America, advised that the construction could be carried out, and completed, if necessary even before the completion of the Kingswood extension and the piece of line in Old Market-street, which had been contracted for in November last, if they would give him a free hand. As this section was practically the same number of lineal yards as the Kingswood extension and the Old Market-street line, the company scarcely hoped for such a result, but relying on Mr. Robinson's advice and assistance they determined to do the work themselves and they placed it in his hands. Cordially co-operating with him was Mr. C. Challenger, the traffic manager, who heartily entered upon the work with his old chief, well knowing that a record had to be broken. The organisation of the labour gangs was perfect. Hundreds of men were thrown upon the work, the old line was rapidly removed and a new line with additional doubling and complicated work in connection with the depôt was completed in one month and two weeks from the date of breaking ground; and on Wednesday last week Mr. Robinson was able to report to the directors that the work was completed within the time he had named. The directors were so pleased at this remarkable smartness that they voted £100 for distribution amongst the foremen of the gangs and others engaged in the work as an acknowledgment of the way in which they had stuck to their posts night and day, and the smartness with which everything had gone in the face of the

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great traffic difficulties in such busy thoroughfares as West-street and Lawrence-hill. The company were so gratified that they only regretted the dispersion of a construction staff which had carried out this smart work in such a satisfactory manner, not only as to time, but with regard to efficiency and greatly reduced cost.

St. Pancras.—The Finance Committee of the London County Council on Tuesday reported that they had considered an application from the St. Pancras Vestry for a further loan of £75,000 for electric lighting. The report continued: "The Vestry, as will be in the recollection of the Council, has already established an electric lighting station in Stanhope-street, has laid mains in various streets, and has built battery sub-stations in High-street, Camden Town, and in Regent's Park-road. On these various works the Council has already advanced or sanctioned loans to the extent of £107,700, and the Vestry finding the demand for electricity is increasing beyond the capacity of the Stanhope-street station, and also to assist in disposing of the parish refuse, now propose to construct a combined electric lighting station and refuse destructor, for which the present loan is required. The Vestry has acquired certain premises in King's-road, Camden Town, for a central lighting station for £8,592. 1s. 10d., and Bangor Wharf, in Georgiana-street in connection with the collection, removal and disposal of house and street refuse (to be used in connection with the electric station) for £9,924 The buildings and works are estimated to cost £27,201, and contracts have been entered into for about £25,000 of this amount. The cost of the necessary engines, dynamos, boilers, switchboards, mains, etc., is estimated at £35,569. in respect of which contracts have already been entered into for £32,092. 10s. 3d. In addition to the electric lighting machinery referred to there are an engine and boiler, two mortar mills, stonebreaker, fans, and other appliances intended for use with the refuse destructor, in respect of which contracts have been taken for £1.100, making with professional and other charges a total of £34 760. 10s. 3d. The Vestry asks that the whole cost may be treated as a loan for electric lighting purposes, and spread over 42 years, but we are of opinion that the cost in connection with the removal and disposal of the street and house refuse must be treated separately, and regard had to the life of that part of the outlay. As the Vestry does not require to take up the whole of the £75,000 at once, we consider that the loan should be limited to the amount at present required—viz. £56,100—and made subject to a restriction as to further borrowing to supply any necessary replacement of plant and machinery until the amount raised has been paid off, any plant requiring to be renewed in the interim being defrayed out of a sinking fund for renewals, or from maintenance account. We accordingly recommend: (*a*) That, subject to the Council hereafter giving its written consent under seal to the borrowing, and subject to all necessary consents and evidence being furnished to the satisfaction of the solicitor of the Council, the application of the Vestry of St. Pancras for a loan of £75,000 towards defraying the cost of purchasing the necessary site for and carrying out an electric light installation, and erecting the requisite buildings and plant, and providing and laying the necessary mains in the parish, and also in providing a wharf and land, plant, buildings, and machinery in connection with the collection, removal, and disposal of the house and street refuse of the parish, be granted to the extent of £30.000 for electric lighting purposes, on condition that the loan be taken up at once, interest being charged thereon at the rate of £2. 17s. 6d. per cent. per annum calculated quarterly, and with the principal being repaid by such equal half-yearly payments of principal and interest combined as will repay the amount borrowed within a period of 42 years; that it be referred to the solicitor to take the necessary measures for completing the loan, and that the amount be advanced out of the Consolidated Loans Fund. (*b*) That it be notified to the Vestry of St Pancras that as they had elected to spread the whole of the initial cost of the electric light installation over 42 years, the Council will decline to give its sanction to the raising of any loan to replace plant and machinery which may be necessary during the currency of the loan, and will expect the Vestry to provide for all renewals required during that period out of a sinking fund to be provided, or from maintenance account. (*c*) That, subject to the Council hereafter giving its written consent under seal to the borrowing, and subject to all necessary consents and evidence being furnished to the satisfaction of the solicitor of the Council, the application of the Vestry of St. Pancras for such portions of the above-mentioned loan of £75,000 as relate to the collection, removal, and disposal of the house and street refuse of the parish, be granted to the extent of £26,100 for purchasing the premises, and providing the necessary buildings, plant, and machinery in connection with the collection and disposal of the house and street refuse of the parish, on condition that the loan be taken up at once, interest being charged thereon at the rate of £2. 17s. 6d. per cent. per annum, calculated quarterly, and the principal being repaid by such equal half yearly payments of principal and interest combined as will repay the amount borrowed as to £10,500 within a period of 54 years, as to £9.000 in 30 years, as to £5 400 in 15 years, and as to £1,200 in 12 years; that it be referred to the solicitor to take the necessary measures for completing the loan, and that the amount be advanced out of the Consolidated Loans Fund. To enable this loan to be completed during the recess, it is necessary that the Council should seal an order sanctioning the borrowing. We have added the amount to the list of the proposed payments, and recommend that the seal of the Council be affixed to the formal orders."—The Electricity Committee of the Vestry have declined to give leave to the London Hydraulic Power Company to lay mains for the service of Messrs. Saunders's premises, 15, Charlotte-street, W., to extend along Tottenham Court-road, Windmill-street, and across Charlotte-street. The reason of the refusal is asserted to be the objection on the part of the committee to the possibility of the company being a rival which should supply motor power so that business premises could supply their own electricity.

Electric Lighting Loan.—The Finance Committee of the London County Council on Tuesday reported: "We have again had under consideration the application of the Vestry of Islington for a loan of £51,000 for the purposes of electric lighting. On January 22 last we recommended the Council to sanction a loan of £18,000 towards the cost of erecting a central station at Eden-grove, Holloway repayable in 50 years, and of £33,000 to provide the necessary plant and machinery, mains and pipes, repayable in 20 years The consideration of the matter was adjourned by the Council from January 22 to January 29, when the recommendation was withdrawn on the implied understanding that a further representation should be made to the Treasury with a view to obtaining an alteration in the periods to be allowed for repayment of loans for the initial cost of electric lighting installations. Our further correspondence with the Treasury was presented to the Council on May 7, the effect of it being that as an alternate method of repayment the Treasury was prepared to approve of an all-round period of 42 years for the entire cost, with a restriction as to further borrowing for replacement until the amount raised had been paid off; any plant requiring to be renewed in the interim being paid for out of a sinking fund for renewals or from maintenance account The Vestry of Islington having been informed of the Treasury decision and of our willingness to recommend the Council to sanction the borrowing of the £51,000 on those terms, either for 42 years for the whole amount, or divided (as above mentioned) for 50 and 20 years, the Vestry replied that they were not prepared to accept the terms offered, and they asked the Council to sanction the borrowing unconditionally of the sum required, the loan to be repaid as provided by Section 190 of the Metropolis Management Act, 1855. This section enacts that for the purpose of providing a fund for paying off mortgages granted under the Act, the Board or Vestry granting such mortgage shall once in every year set aside out of the moneys or rates charged thereby such sum as they think proper, being not less than £2 per cent. on the amount of the principal moneys secured thereby, and the sum so from time to time set aside and all other moneys applied by the Board or Vestry in augmentation of the said fund, is to be applied in paying off the loan, or investing at compound interest until the whole of the principal can be discharged. In making this request it did not appear to us that the Vestry had sufficiently recognised the fact that it is the duty of the Council, not only to see that loans are required for purposes authorised by statute, but to safeguard the interest of future ratepayers by not allowing any burthen of debt to be placed on them which should be borne by the present occupiers; and, moreover, that it has always been the custom to restrict the period of loans to the life of the works to be executed, except that, as previously stated, by arrangement with the Treasury an exception has now been made in the case of electric lighting works for the whole initial cost to be included in one period of 42 years, subject to the special condition above stated. Reporting on a similar application from the Vestry of St. Pancras on May 7, we stated that we considered the condition was a fair one and one which the Council should accept, and the Vestry of St. Pancras also consenting, the loan was concluded on that basis In offering the Vestry of Islington the same terms we considered that we had gone as far as the Council could reasonably be asked to go in facilitating the borrowing of the money, and that we could not advise the Council to give an unconditional sanction to the Vestry borrowing the £51,000. The Vestry has since reconsidered the matter and now asks the Council to sanction the borrowing of the £51,000 and also to lend the money at £2 17s. 6d. per cent, the loan to be repayable in 42 years on the annuity system. This request may now be complied with, subject to a restriction as to further borrowing to supply any necessary replacement of plant and machinery until the amount raised has been paid off, any plant requiring to be renewed in the interim being defrayed out of a sinking fund for renewals, or from maintenance account. We recommend: (*a*) That, subject to the Council hereafter giving its written consent under seal to the borrowing, and subject to all necessary consents and evidence being furnished to the satisfaction of the solicitor of the Council, the application of the Vestry of Islington for a loan of £51,000 towards defraying the cost of an electric light installation in that parish be granted on condition that the loan be taken up at once, interest being charged thereon at the rate of £2. 17s. 6d. per cent. per annum, calculated quarterly, and with the principal being repaid by such equal half-yearly payments of principal and interest combined as will repay the amount borrowed within a period of 42 years; that it be referred to the solicitor to take the necessary measures for completing the loan, and that the amount be advanced out of the Consolidated Loans Fund. (*b*) That it be notified to the Vestry of Islington that as they have elected to spread the whole of the initial cost of the electric light installation over 42 years, the Council will decline to give its sanction to replace any of the plant and machinery which may be necessary during the currency of the loan, and will expect the Vestry to provide for all renewals required during that period out of a sinking fund to be provided or from maintenance account. As the Vestry is anxious to complete the loan, it is necessary that the Council should seal an order sanctioning the borrowing and draw a cheque for the amount of the loan. We have accordingly included the same in the supplementary weekly cash paper, and also the amount required

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for the stamp duty on the mortgage, and recommend that the seal of the Council be affixed to the formal order."

PROVISIONAL PATENTS, 1895.

JULY 22.

13934. **Improvements in the method of generating electricity for lighting or motive power.** Frederick Gray, 2, Southwood-lane, Highgate, London.

13956. **Improvements in trolley systems of electric propulsion and in apparatus therefor.** Anthony George New, 55, Chancery-lane, London.

13957. **Improvements in trolley systems of electric propulsion and apparatus therefor.** Anthony George New, 55, Chancery-lane, London.

13958. **Improvements in trolley systems of electric propulsion and in apparatus therefor.** Anthony George New, 55, Chancery-lane, London.

13961. **Improved connector for the rails of electric tramways and railways.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (The Compagnie de l'Industrie Electrique, Switzerland)

JULY 23.

13978. **Improvements in the method of and means for stopping electrically-propelled cars.** Arthur Knox Bonta, 70, Market-street, Manchester. (Complete specification)

14014. **An improved electric switch.** Herbert Sefton Jones, of the firm of W. P. Thompson and Co.. 31, High Holborn, London. (Henry Stuebner, Henry T. Paiste, and Warren G. Miller, United States.)

14019. **Improvements in or connected with apparatus for electrically lighting miners' safety lamps.** William Ackroyd and William Best, 33, Chancery-lane, London.

14021. **Improvements in and relating to phonographs and the like.** Edwin Smith, Wallace Lodge, Upper Tooting, London.

14023. **Improvements in writing telegraphs.** Philip Arthur Newton, 6, Bream's-buildings, Chancery-lane, London. (Thomas Ewing, jun., United States.) (Complete specification.)

14033. **Improvements in galvanometers.** George Keith Buller Elphinstone, of the firm of Elliott Bros.. 101, St. Martin's-lane, London. (Henry Rowland, United States.)

14049. **Improvements in electric arc lamps.** Daniel Higham, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14051. **A method and apparatus for electrically transmitting writings or drawings.** Bennett Pell, 28 Southampton-buildings, Chancery-lane, London.

14066. **Improvements in winding armatures for dynamos and electromotors, specially applicable to alternators and alternate-current motors.** The Hon. Charles Algernon Parsons, 18, Southampton-buildings, Chancery-lane, London.

JULY 24.

14095. **Improvments in electric battery cells and in the method of applying same.** Bris Doyle, 43, Kennington Park road, London.

14113. **Improvements in the electrolysis of alkaline chlorides.** Alfred Roland Davis, 4, South-street, Finsbury, London.

14114. **Electrical apparatus having movements determined by variations of the electrical resistance of bismuth in a magnetic field.** Johannes Hessberger, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14134. **Improvements in rapid telegraphic transmission on cable lines.** Charles Langdon-Davies, 24, Southampton-buildings. Chancery-lane, London.

JULY 25.

14142. **Improvements in apparatus for the recovery of gold by electrolysis from the sea.** Matthew William Wallbank Mackie, 77, Turnmill-street, London.

14147. **Improvements in electric and other railways and in vehicles therefor.** Robert Cooke Sayer, 11, Clyde-road, Redland, Bristol.

14158. **Improvements in and relating to primary batteries.** Walter Rowbotham, 47, Vittoria-street, Birmingham.

14160. **Improvements in conduits for electric wiring.** Edward William Lancaster, 52, Bristol-road, Edgbaston, Birmingham.

14203. **Improvements in electric switches or parts for making and breaking circuits in electric machinery.** William A'Court Granville Birkin, 1, Queen Victoria-street, London.

JULY 26.

14233. **Process of making acid-proof vessels and electric insulators.** Edward Whitworth and Bris Doyle, 43, Kennington Park-road, London.

14246. **Improvements in alternating-current electric motors.** George Edensor Dorman, The Hawthorns, Newport-road, Stafford,

14257. **Improvements in or connected with the arrangement of conductors for electrically-operated agricultural implements.** Hugo Schimpff, 4, South-street, Finsbury, London.

14267. **Improvements in dynamo-electric machines.** George Frederick Dieckmann, 45, Southampton-buildings, Chancery-lane, London.

14275. **Improvements in and connected with junction-boxes for electric mains.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

JULY 27.

14313. **Improvements in the manufacture of carbon plates, cylinders, and cells for electrical purposes.** Robert Henelade Courtenay, 23, Broad Hinton-road, Clapham, London.

14337 **An improved method of and means for working electric fire-alarms.** Johannes Andreas Bakker, 191, Fleet-street, London. (Complete specification.)

14342 **An improved electrolysing apparatus.** Jules Kolb and Alexandre Daniel Arnold Lambert, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1892.

16046. **Electrolytic decomposition of alkaline salts.** Castner. (Third edition.)

1894.

15985. **Arc lamps.** Akester and Price.

16599. **Regulating electric currents.** Miller.

16857. **Telegraphy.** Delany.

1895.

6681. **Electric switches.** Cronin.

8011. **Electric battery plates.** Hübener.

9513. **Incandescent electric lamps.** Sheppard.

9703. **Electrically transmitting power to vehicles, etc.** Porter.

9806. **Electrolytical apparatus.** Comboul.

10587. **Electric heaters.** Reed.

10930. **Electrolysing chloride solutions.** Hermite and others.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5¾
Brush Company, Ordinary	3	2-2½
—— Nom. Cum , 6 per cent. Pref.	2	2½-2¾
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5½-5¾
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	16-16½ xd
—— 5 per cent. Debenture Stock	100	131-134
City and South London Railway, Consolidated Ordinary	100	41-43
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14½-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A 1-200 of £50	100	—
Electric Construction, Limited	2	¾-1
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	2-2½
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	¾-1½
Elmore's Wire Company	2	¾-1¼
Fowler-Waring Cables	5	¾-¾
W. T. Henley's Telegraph Works, Ordinary	10	10¾-11¼ xd
—— 7 per cent. Preference	10	15-15½
—— 4½ per cent. Debentures	100	104-107
House-to-House Company, Ordinary	5	3¾-4
—— 7 per cent. Preference	5	7¼-7½
India Rubber and Gutta Percha Works	10	19-21
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅞-7¾
—— Pref.	—	—
Liverpool Overhead Railway	10	10 7/16-10 9/16
—— 5 per cent. Pref.	10	15-15½
—— 4 per cent. Mortgage Debentures of £100	100	110-112
London Electric	5	1-1⅛
Metropolitan Electric Supply	10	10¾-11¼
—— 4½ per cent. First Mortgage Debenture Stock	100	116-119
National Telephone, Ordinary	5	6-6½
—— 6 per cent. Cum. First Pref.	10	16-17
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-107
Notting Hill Company	10	8½-8¾
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7¼-7¾
—— £4½ shares	4½	5¾-6¼
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8-8½ xd
—— 7 per cent. Pref.	5	9-9½ xd
Swan United Ordinary	3	2-2¼
—— 4½ per cent. Debentures	100	104-107
Telegraph Construction and Maintenance	12	43-45 xd
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4¼-4⅝
Westminster Electric Supply, Ordinary	5	7¾-8¼ xd
Yorkshire House-to-House	5	5¼-5¾

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NOTES.

Electric Lighting in Japan.—Mr. Troup, the British Consul at Yokohama, suggests that it would be well to the interest of those who supply electric lighting plant to have expert agents in Japan with detailed specifications at hand when enquiry is made.

Hardly Fair.—The Prague City Council have decided, upon the ground that "no foreign money should be invested in Prague," to reject the whole five tenders for the construction of an electric tramway system in the town, and, in conjunction with the various suburban authorities, to build and work the lines themselves.

The Wail of the Gasman.—Colonel W. T. Makins, who presided at the half-yearly general meeting of the Gaslight and Coke Company the other day, was sad at heart on account of the Thames Embankment. He expressed the hope that the London County Council would experiment with incandescent gas burners on the embankment before deciding on the electric light.

Telephony in Sweden.—Sweden's State telephone is soon to be connected with the State telegraph. Instead of addresses the telephone numbers will be used, the telegraph clerk looking up the address. Messages may be telephoned to the telegraph office and telephoned back, thus dispensing with the greater number of the messenger boys, as in Sweden nearly everyone uses the telephone.

Extraordinary Natural History.—"Prof. Forbes, like most electricians, knows how to crow; but at least, unlike the majority of his professional brethren, he has laid his egg first." So says the *Journal of Gas Lighting, Water Supply, etc.* It will be news to most of our readers that a cock—which is the bird that crows—is capable of laying eggs. Possibly, however, in the gas world the hens go in for crowing.

An Electric Flag.—It is stated that an electrical novelty in the shape of a standard intended for night use has just been delivered from the Kiel dockyard to the German Imperial yacht "Hohenzollern." The flag is four metres square, and the design is traced in coloured electric lamps, which are lighted by a wire from the deck. An experimental illumination proved very successful, and gave the utmost satisfaction to the spectators.

Glasgow Harbour Tunnel.—In our issue of the 12th ult. (page 36), in a description of the Glasgow Harbour tunnel, we stated that the whole of the mechanical work was under the superintendence of Mr. D. H. Morton. This gentleman wishes to state that he was not responsible for the elevators, the credit of the very successful working of which is due to the American Elevator Company, who were entirely responsible for the designing and execution of the work.

The Trans-African Telegraph.—A telegram from Cape Town, dated 2nd inst., states that the Hon. Cecil Rhodes, in reply to a question in the House of Assembly on that day, stated that the proposed trans-continental cable from Cape Colony to Egypt would be eventually built, provided the Imperial Government recognised the obligations with respect to the Soudan, and rendered the work of construction possible by clearing the country of the Madhi and his followers.

Electric Lighting in Austrian Mines and Metallurgical Establishments continues to make steady progress. The State silver smelting works at Pribram are already equipped with it. Then, in the course of the present year, the group of mines to which the Marien, Franz Josef, and Adalberti pits belong is to be electrically lighted, and the illuminant is also to be introduced in the Anna and Prokopi mines at Birkenberg. The installations will be carried out by a local firm.

The First Electric Tramway in Berlin will be opened during this month in the northern portion of the city. The line, which has been built by Messrs. Siemens and Halske, connects the Gesundbrunnen with Pankow. Current is supplied through overhead wires. At every important street crossing, and at distances of about 300 yards, stopping-places are erected. The tramcars will run about every 10 minutes at a maximum speed of 16 English miles an hour. The fare for the whole distance will be 10 pfennige.

The Metric System.—The report of the Committee on Weights and Measures, advocating the adoption of the metric system in Great Britain, has been reinforced, says the *Pall Mall Gazette*, by a proposal which the French delegates to the Geographical Congress were commissioned to place before the Government here. This is, that if the British Government will make the metric system obligatory throughout the Empire, the French Government, in return, will abolish the Paris meridian of longitude and accept that of Greenwich.

Institution of Electrical Engineers.—We are in receipt of No. 118, vol. xxiv., of the *Proceedings* of the Institution. It contains the papers on "A Magnetic Tester for Measuring Hysteresis in Sheet Iron," by Prof. Ewing, and "The Recent Development of the Single-Acting High-Speed Engine for Central-Station Work," by Mr. Mark Robinson, with discussions on same; description of Mr. Joseph Edmondson's "Zero-Torque Electricity Meter"; and "Daily Insulation Testing of Telegraph Lines," by Mr. W. H. Preece.

Parisian Police Boxes.—The Paris correspondent of the *Times* states that the prefect of police has ordered the establishment of 70 "postes vigie" in various parts of Paris. These will consist of kiosks, in which there will always be by day a policeman to give information or help, and at night a second policeman outside to watch the neighbourhood. Each kiosk will eventually be connected by telephone or telegraph with the nearest police station. The officers are to keep a register of the applications made to them. This is likely to be trivial enough for contemporaries, but may be interesting 100 years hence.

Light Railways.—Some interesting reports from British representatives abroad on the subject of light railways have just been issued. Their publication has been delayed owing to the despatches having been placed, in manuscript, at the disposal of the committee of the conference convened by the Board of Trade to consider the question of light railways and tramways. In Belgium there are 75 such lines extending over 836 miles. Of these, six belong to private companies and the remainder to the National Society of Local Railways. Dividends have been steadily increasing. Agricultural products have certainly been benefited by the establishment of light railways, the most remarkable instance being the culture of beetroot, which has received a great impetus, and has, in turn, given rise to the establishment of a large number of sugar factories. In Prussia the light railways, or "Kleinbahnen," number 37, with a total mileage of about 480 miles. Of these the German Government says: "In general the light railways appear to be well adapted to the development and improvement of agriculture and forestry and their accessories, particularly to opening up new markets and facilitating the carriage to and fro of manure and raw produce over a considerable area of country."

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The Telephone in Russia.—Russian telephones are divided into three classes—those belonging to and worked by the State; those appertaining to private and public companies under a contract with the State; and those erected by municipal authorities, railway companies, and private persons for their own use. In 1894, there were in operation 34 State telephone systems, with 43 exchanges. In that year public telephone lines were laid in Tomsk, Tjumen Jaroslav, Smolensk, Chernigov, Jalta, and Gatschina. The number of subscribers was 9,398; the lines were 2,582 versts in length. There were 11 telephone systems of the second class mentioned, with 8,000 subscribers and 1,152 versts of lines; while the number of private telephones is stated to be "very large." In January of the present year, State telephone lines were inaugurated at Ekaterinoslav and Feodosia, and others are in course of installation, or are projected, at Samara, Yambov, Poty, Batoum, Novorrossijsk, Berdyansk, Jekaterinoslav. From January, 1895, the tax on municipal telephones has been reduced by 25 per cent. in order to encourage the development of the use of the telephone in the Tsar's dominions.

Indirect Electrolysis.—M. Andreoli has described in *Le Génie Civil* an experiment on indirect electrolysis. Taking a cell divided into three compartments by porous diaphragms, a solution of any salt is placed in the central compartment, whilst the two electrodes are placed in the side compartments immersed in similar or different electrolytes. The decomposition of these latter is, on the current being passed, effected as if the central compartment did not exist, the solution in it being unaffected. In this form the experiment is an old one, but M. Andreoli finds that if a plate or series of plates is placed in the solution in the central compartment, reactions occur which can only be attributed to an indirect or secondary electrolysis. If, for example, the two outer compartments are filled with a solution of common salt, and the central one with a solution of cyanide of gold. Let the anode in the one compartment be of carbon, and the cathode in the other of iron. On passing a current under these conditions chlorine is evolved at the carbon electrode, and caustic soda produced at the other, the cyanide solution being, as aforesaid, unaffected. If, however, whilst the current is passing, a series of metal plates are immersed in the cyanide solution, the gold is deposited on them, though neither chlorine nor soda appears to pass into the central compartment.

Personal.—The Queen on Saturday last held at Osborne a private investiture of the Orders of the Bath, the Star of India, St. Michael and St. George, and the Indian Empire. Mr. William Robert Brooke (late Director-General of Telegraphs in India) was introduced into the presence of the Sovereign, received the honour of knighthood, and was invested by her Majesty with the insignia of the Second Class of the Order of the Indian Empire.—In the course of an article on Lord Kelvin in the *Pall Mall Magazine*, the writer says that he has an extraordinary capacity for turning from one task to another, as if he found inspiration in the change. And yet all his work is elaborate, painstaking to the last degree. If, as they say, genius is the capacity for taking pains, then Lord Kelvin is one of the greatest of this or any age. The other day he delivered a presidential address before the Royal Society, and in it he made use of this expression: "Tribulation, not undisturbed progress, gives life and soul, and leads to success where success can be reached, in the struggle for natural knowledge." It has been said that Lord Kelvin's career has been one of steady progress in the lines of success. So it has, as we may see if we survey the achievements of his half-century of untiring toil. But no one knows except the man himself what tribulation, what disappointments, what long exercise of patience, have preceded the many important discoveries with which his name is associated. He is an indefatigable worker. Investigation must needs be accompanied by unbreakable precision, and this quality Lord Kelvin has to an astonishing degree.

Municipal v. Private Enterprise.—Mr. W. O. Rooper, of Stafford, writes to a local paper as follows: "An impression has arisen in the minds of the inhabitants of Stafford that the Corporation officials are the only persons competent to put up electric light installations taking their current from the public supply mains. In canvassing for work, one is invariably met with the reply, 'Oh, as the Corporation is supplying the current, they will have to test the work, and they may not be satisfied with other firms installations.' Now, at the request of the Corporation officials, I last year went to considerable expense in providing an electric light show at the gas exhibition. I have been engaged in the business for the last 10 years, and have done work in all parts. I use the very best material and employ the most skilled men, and have never fitted up an installation that would not stand the proper tests. Now, when there is a chance of work in the town where I have been a ratepayer for so long, I find it nearly impossible to get employment, owing to the action of our municipal authorities. What is there about the business that makes it necessary for the Stafford Town Council to do it themselves when nearly all other councils in the country leave it to private firms? Why should they not as reasonably become purveyors of meat, bread, coal, or any other commodity? At any rate, if they will do their best to stifle private enterprise, let them do it fairly and squarely, and give up suggesting that they are the only people able to carry out electric work satisfactorily." Mr. Rooper is, however, under a misapprehension in thinking that Stafford is the only town where the municipality undertakes installation work. His grievance is one which exists elsewhere also.

Technical Education.—The following letter has been addressed to the clerks of county councils and to the secretaries of the other bodies enumerated: "Society of Arts, Adelphi, London, W.C., July, 1895.—Dear Sir,—At a largely attended conference on technical education, held at the invitation of this society on June 20 last, the following resolution was passed: 'That, in the opinion of this meeting, it is desirable that provision should be made for examination and inspection in the subjects of instruction undertaken by technical instruction committees, but not at present included in the schemes of the Science and Art Department, the City and Guilds of London Institute, and the Society of Arts, and that, with the object of giving effect to the same, this conference recommends that a representative committee be appointed to draw up a report and prepare recommendations upon the whole subject.' The council of the Society of Arts, desiring to carry into effect the wishes of the conference, have determined to invite the following bodies to nominate representatives on such a committee, which it is proposed to complete by the addition of members of the society's council: the county councils and county borough councils, the City and Guilds of London Institute, the Royal Agricultural Society, the Central Chamber of Agriculture, the National Association for the Promotion of Technical and Secondary Education, the London Chamber of Commerce, the Yorkshire Union of Institutes, the Union of Lancashire and Cheshire Institutes. I am desired to ask whether the technical instruction committee of your county council will be good enough to nominate someone to serve on the committee, which it is proposed shall be summoned to meet at a con-

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venient date after the summer recess.—Yours faithfully, HENRY TRUEMAN WOOD, secretary."

A Direct Argentine Cable.—The following telegram has been received by the *Times* from its Havana correspondent: "Telegrams received here refer to the difficulty existing between Great Britain and Brazil in connection with Trinidad Island. The island was formally annexed by her Majesty's ship 'Barracouta' in January last, the gunner being appointed governor and the surgeon medical officer. The islet, which is uninhabited and contains no signs of animal life, lies 700 miles to the east and a little to the south of Rio de Janeiro. The party from the 'Barracouta' found the landing difficult. They landed on the western side, where there was much surf and no shelter, and climbing up the precipitous rocks formally read the proclamation of annexation, nailed the British flag on a spar, and buried the proclamation in a bottle at the foot. The exploring party found fresh water in a small valley on the eastern slope and some slight vegetation near the water. In other places there were traces of the stumps of large trees, but no growth. This is the personal report of Lieutenant Ryan, of the 'Barracouta.'" It appears that the situation of this island is such that it forms a convenient landing-place for a direct Argentine cable, free from Brazilian control; this has been talked of for some years back. The decree recently issued by the Brazilian Government directing the purchase of the cables which are laid along the Brazilian coast, has probably brought the direct-cable idea into prominence again. The Paris *Temps* thinks that it is not enough to say that the transatlantic cables between England and South America all touch Pernambuco, that this gives Brazil the upper hand in these matters, that it is, therefore, important to find half-way between Europe and the New World an independent spot for the cables, and that Trinidad Island is just such a spot. Such reasoning might justify the exercise of an existing right, but cannot possibly create such a right.

The Meyer System of Instantaneously Stopping Machinery is described by the author, M. Lucien Meyer, in *L'Electricien* of July 27. His object has been to enable workmen, by means of a series of electric pushes placed at convenient places in the shop, to instantly bring the machinery to a standstill at the first cry of distress uttered by a comrade in danger. His invention consists of a group of apparatus capable of acting together or separately. The first instrument is an obturator placed in a box furnished with a safety valve, and which is traversed by the fluid—steam, gas, compressed air, etc. It consists of a clack-valve articulated on an axis which passes through one of the sides of the box. On the end of the axis is a counterweight lever, on the socket of which is fixed a disc fitted with a stop-notch. The catch engaging this notch is jointed, and forms the armature of an electromagnet. When current is sent into this the mechanism closes the clack-valve, thus cutting off the motive fluid. With the obturator alone, however, an immediate stoppage is not acquired; it is necessary to combine this apparatus with a brake acting upon the flywheel or on the shaft. This brake consists of an eccentric way placed at a short distance from the periphery of the flywheel. At the upper part of this way is a trough or hopper, containing a number of indiarubber cylinders or rollers. The front of the hopper is movable, and, when necessary, the rollers are allowed to drop between the way, which narrows as it descends, and the flywheel, which compresses them, a very powerful and yet easy brakage being thus applied. In experiments made with a 20-h.p. engine, working at a pressure of seven kilogrammes and at 90 revolutions, a stoppage in seven seconds was obtained with the obturator alone, and in two-thirds of a second by the combined action of the obturator and the brake. The third instrument is a speed indicator of special construction.

The Physiology of Death by Electric Shock.—In our last issue (page 130) we quoted an item from the *Lancet* on the mode of death from electric shock. Dr. W. S. Hedley, of Brighton, now writes to that paper as follows on the subject: "An annotation attributes death in electric shock to 'stoppage of the heart.' It is useful to enquire how and why this stoppage occurs. Dr. A. M. Bleile, Ohio, has lately investigated the physiological events which in his opinion lead up to it. Experimenting upon dogs with strong currents of stated strength he finds, on examining the heart immediately after death, that 'the left side is completely relaxed and the right side intensely gorged with blood, as are also the large veins in the immediate vicinity of the heart. . . . . Incisions into the animal are not followed by bleeding, and the arteries are contracted down to a very small calibre.' It was suggested, therefore, 'that the current acted upon the arteries through the nervous centre which controls their diameter.' To test this view dilatation of the arteries and fall of blood pressure was affected by bringing the animal under the influence of nitrite of amyl. Under these circumstances a current of 0·24 ampere at 52 volts for three seconds (ordinarily a fatal dose) did not produce death. The conclusion arrived at is 'that death in electric shock is really due to the fact that the current produces a contraction of the arteries through an influence on the nervous system, and that this constriction of the arteries throws in such a mechanical impediment to the flow of the blood as the heart is unable to overcome, and that where drugs are given to counteract this effect much larger doses of electricity than the ordinary can be borne.' The experimental data on which this opinion is based are given in such detail that the experiments can be repeated and results verified. The paper is a useful contribution to the physiology of death by electric shock. It may be incidentally mentioned, however, that the absolute amount of mechanical energy used, as measured in joules, does not necessarily bear any direct relationship to the physiological effects of an electric current. In other words a weak current for a long time is a very different thing from a strong current for a short time, although in each instance the joules may be the same."

The Science and Art Department.—The following associateships, Royal scholarships, and prizes have been awarded by the Department of Science and Art of the Committee of Council on Education for the session 1894-95 of the Royal College of Science, London, with which is incorporated the Royal School of Mines:—Associateships: Royal College of Science.—Mechanics—1st class, Cecil A. S. Baxter; 2nd class, William F. Nixon and William E. Tubbs. Physics.—1st class, Harold R. Cullen and Robert W. Forsyth; 2nd class, Walter Hewson, William H. Kay, and Joseph H. Vincent. Chemistry.—1st class, Hugh A. M. Borland, John J. Green, Francis C. Harrison, Henry W. Hutchin, William Longshaw, Arthur Nicholls, William F. Swords, and John Thomas; 2nd class, George D. Dunkerley, Reginald W. Ferguson, Herbert G. Hathaway, Andrew More, George Ryce, William Saunders, John Watson, and Frederick P. Wratten. Geology.—1st class, with honours, Thomas Barron; 1st class, James Harrison and Ernest W. Vredenburg; 2nd class, Frank Ackroyd and Henry W. L. M'W. Bourke. Zoology.—1st class, Ernest Stenhouse. Botany.—1st class, William G. Freeman. Royal School of Mines.—Metallurgy—1st class, Leonard

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G. Attenborough, John C. Moulden, William H. Rudd, William E. Simpson, and Basil W. Turner; 2nd class, George H. Biggs, Gerald N. Brown, Edward H. Clifford, Hugh C. M'Neill, Harry R. Prescott, and William J. Turner. Mining.—1st class, Heneage W. Finch and Robert W. Pringle; 2nd class, Cecil M. Bryant, Herbert T. Butcher, Thomas L. Dawson, Henry A. Hinton, Edgar S. Jones, Clive S. Long-Innes, Percy W. Lucas, Hugh C. M'Neill, Belfield Marais, and James Morris. Royal Scholarships.—First Year's Royal Scholarships—Ernest Smith, George M. Russell, Frank Fisher, Norton Baron; Second Year's Royal Scholarships—Robert Sowter, Joe Crowther. Medals and Prizes.—Edward Forbes Medal and Prize of books for biology, William G. Freeman; Murchison Medal and Prize of books for geology, John Caspell; Tyndall Prize of books for physics, Part I., William H. White; De la Beche Medal for mining, Robert W. Pringle; Bessemer Medal and Prize of books for metallurgy, John C. Moulden; Frank Hatton Prize of books for chemistry, William Longshaw. Prizes of books given by the Department of Science and Art.—Mechanics, Cecil A. S. Baxter; astronomical physics, Ernest E. L. Dixon, William H. White; practical chemistry, Henry W. Hutchin; mining, Robert W. Pringle; principles of agriculture, William Williams.

Niagara Falls at Work.—Another contribution to correspondence on this subject (see *Electrical Engineer*, August 2, page 128) comes from Mr. Francis Lynde Stetson, who says: "In the issues of the *Times* there have appeared letters from Prof. George Forbes and Lord Kelvin concerning the adoption of the alternating current for the electric power installation at Niagara, and referring to the advice given by them to the directors of the Cataract Construction Company, which did the work. As first vice-president of that company, which sought and gladly received the advice of these two eminent engineers, I feel it due to both of them that the facts should be stated briefly as follows: (1) In January, 1891, Lord Kelvin was chairman, and Prof. Forbes the submitter of a project, to the International Niagara Commission. At the close of that commission everyone condemned and rejected the alternating system, excepting only Prof. Forbes and Messrs. Ganz and Co., of Budapest. (2) In January, 1894, the Niagara directors had adopted the alternating system upon the advice of Prof. Forbes, and with the concurrence of all the expert advisers, including those who had rejected the alternating system in 1891, excepting only Lord Kelvin. Lord Kelvin thereupon sent to us a cable, in which he certainly indicated a strong preference for the continuous current, but intended also (as we are now gratified to learn from him) as recognising that we 'could certainly succeed with the alternate current.' (3) Our decision was thus made because of the prohibitive cost of the continuous-current installation, which in most particulars fully justified the strong preference for it evinced by Lord Kelvin, whose eminent and valuable advice and encouragement we gratefully acknowledge. Except for his early and original support, our plan would have died 'a-borning,' and we thank him for his continuing interest. (4) But the development of our plan must have been long delayed had it not been for the courage and comprehensive knowledge of Prof. Forbes, who alone stood for the absolute commercial advantage of the alternating current, and for his admirable conception of his 5,000-h.p. dynamo, so wonderfully worked out by the Westinghouse Company as to yield 5,315 h.p. in the actual test on June 28, 1895. Prof. Forbes is entitled to the credit, as he must bear the responsibility, of the results of the advice given by him as to the three points stated in his letter of July 25; and we have followed his advice, perhaps not as far as his courage would carry him, yet beyond the former practice of the manufacturers, who now fully occur in the wisdom of his recommendations as adopted. The rotary transformers approved by Prof. Forbes and made by the General Electric Company are worthy of the highest praise for both design and execution. (5) In fine, the extraordinary and gratifying progress in the development of transforming apparatus, and a corresponding reduction of cost, have taken away many, if not all, of the reasons which Lord Kelvin gave against the adoption of Prof. Forbes's original recommendation of the alternating current, which now, as he truly says, 'alone solves the problem well and economically.'"

Lamps Lighted by Electrical Fish.—M. d'Arsonval has been interesting the members of the Académie des Sciences with a description of the experiments which he has recently made in connection with the electric discharge of the torpedo fish. He used several special instruments for recording the phases of the discharge. One of them, which he calls a galvanograph, is a modification of the movable-circuit galvanometer which he devised in 1880 in conjunction with M. Marcel Deprez. It consists essentially of a very light aluminium coil, upon which is wound the circuit traversed by the piscinal current. This coil is fixed to the centre of an indiarubber diaphragm, stretched on a Marey air-drum. This primary drum is connected by an indiarubber tube to a second smaller drum, carrying a short recording needle moving on a smoked cylinder. Another is composed of a silver wire a tenth of a millimetre in diameter and 40cm. or 50cm. long. This wire is stretched horizontally between two rigid supports. In its centre it connects with a second wire held by an indiarubber spring and carrying a needle moving on the recording cylinder. The torpedo is placed on a plate with a metallic bottom, on which is left about ½in. of sea-water to enable the fish to breathe during the experiments. Out of a sheet of tinfoil two electrodes are cut in the shape of the electric organs of the animal, and these two strips are placed on the dorsal surface of these organs and joined by a band of tinfoil 5cm. long. The lower metallic plate constitutes the negative electrode, and the tin strips form the positive electrode of this living electromotor. The electrodes are then united to the various apparatus for measuring or rendering visible the discharge of the organs. To provoke the discharge it is only necessary to pinch with a pair of dissection tweezers the edge of the fins of the fish. As a rule the torpedo contents himself with one discharge of his electrical artillery, but if he be pinched hard he loses his temper and fires rapidly. The curve inscribed by the galvanograph shows that the discharge is not continuous, as M. Marey has asserted that is is; it is composed of from six to ten successive discharges. The back of the fish is always positive and the belly always negative. With torpedoes of about a foot in diameter, which had been kept for about a week in the Laboratoire de Zoologie et Physiologie Maritimes de Concarneau, M. d'Arsonval found that the E.M.F. alternated between eight and seventeen volts, and the intensity between one and seven amperes. He took an incandescent lamp, consuming four volts and one ampere, and connected it to one of the electrical organs. When the fish was tweezed this lamp became brilliantly lighted for an instant. He counsels the experimenter, by the way, to connect the lamp with only one of the organs, and to pinch the fish very lightly, otherwise the lamp will inevitably be destroyed, as happened to him at his initial attempt. He was able to get three lamps—all he had—running. The action of the organs is synergetic and homergetic. Lamps placed on each organ lighted at the same time and showed the same intensity, although on different circuits. The organ, however,

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rapidly exhausts itself. M. d'Arsonval purposes continuing his experiments, and we shall probably shortly have from him a comparison of the respective electrical powers of the torpedo, the gymnotus or electric eel, and the electric cat—*malapterurus electricus*.

The Falls of Foyers.—The letter of the Duke of Westminster on this subject, to which we referred in our "Notes" of last week, has given rise to a number of letters in the daily papers, in most of which only the æsthetic point of view is taken, and which are not of much interest. The members of the Inverness Field Club visited Foyers and district on Saturday. They were welcomed to the scene of the operations of the British Aluminium Company, Limited, by Dr. Common, F.R.S., resident director, and Mr. Peregrine Birch, engineer. It was seen that the construction of the conduit to convey the water from above the falls to the site of the factory on the western edge of Foyers Bay was being pushed forward by the contractor. For two-thirds of its length the conduit will be in tunnel through the solid rock. It will be about half-a-mile long, and its dimensions are 6ft. by 6ft. About 300 navvies are employed on the work at present, as well as skilled men over them. The conduit runs parallel with the river where it forms the falls, but it is some 20ft. underground, and, so far as could be discerned, the scenery surrounding the falls will not be damaged, although the water will be diverted into the conduit. The overflow of the reservoir will pass into the gorge of the falls. Dr. Common, in the course of an interesting speech, said that all the necessary elements for the cheap production of aluminium have been found in the United Kingdom. Bauxite, the raw material, is extensively found in the mines in the North of Ireland. It will be treated in the company's factory at Larne by a simple chemical process, by which the alumina will be extracted. This alumina will be brought to the factory at Foyers, and there subjected to the electrolytic treatment, by which the pure aluminium will be separated from the oxygen, the latter going away in the air. The pure aluminium will then be collected in the form of ingots and shipped from Foyers to the industrial centres. No solid *débris* of any kind will result from the process under which the company will work. The cost of manufacturing aluminium by steam power would be about £20 per horse-power per ton, whereas at Foyers the cost of manufacture by water power would be £4 or £5 per horse-power per ton. It was that difference that brought the company to Foyers, which they have purchased. He referred to the many uses of aluminium, dwelling upon its great value as an alloy. The damage by their operations to the scenery, Dr. Common assured the visitors, will be absolutely nil. From the utilitarian point of view the opposition to the company, as expressed in the Duke of Westminster's letter to the papers, was absurd. The forces of Nature—such as these falls—should be used for the benefit of mankind, as they were all over the world. Even if there was a little damage to the beauties of Nature, that must be put up with. It would be the object of the company to do as little damage to the surroundings as possible. Nothing would destroy the natural beauty of that glen. The fact of a little water coming down through it or not was a mere detail. The beauty was in the surroundings. Provost Ross asked if there was any truth in the statement that the vegetation would be destroyed. Dr. Common said that, while a good deal of hydrofluoric acid had been given off by the furnaces in the early days of the manufacture of aluminium, it was now absorbed and rendered absolutely innocuous. The remarks of the Duke of Westminster about spoil heaps were also quite baseless. Provost Ross said it was very gratifying to hear those assurances from Dr. Common, and the best thing they could do, in the interests of the Highlands, would be to wish the company all success.

Requires a Grain of Salt.—Dr. Herz has been interviewed by the young man of the *Pall Mall Gazette*, who has calmly swallowed all that was given to him to swallow. His story runs that Dr. Herz expounded the secret of a great invention which he claims to have left behind him. What the details are cannot be revealed, for up to now they are not patented. "But you may believe on my word," said the dying man, noticing a shade of scepticism in his listener, "that what I tell you is the minimum—not the maximum—of what my invention will accomplish. You know that at present, owing to various causes of retardation, the best telegraphic instruments are incapable of transmitting more than 20 words a minute over long submarine cables. By my system it will be possible to transmit upwards of 100,000 words in the same short space of time. You will say that this sounds like a legend—like a wild flight of fancy, but it is not. It is fact already accomplished and capable of application to-morrow to all the instruments in existence. My experiments were carried out years ago before I came to England and fell ill. I had at my disposal all the telegraphic lines of France during the night, and the hours when they were not required by day. Since I have been here I have worked the system out completely in its mathematical and all its other bearings. It only awaits the opinion of a well-known patent lawyer, and then the world may have the details." "Have you calculated the effect of such an invention as you describe?" "I have. It will revolutionise communication throughout the world. My system permits, in the first place, of so reducing the price of communication that it will be possible to cable a message of 50 words for the 2½d. which at present it costs to send a letter. In other words, the maritime postal service will be reduced to the condition of a parcels post, all verbal communication being instantaneous and practically void of cost. In the next place, consider the newspaper of the future. Papers spend very large sums upon private telegrams from different parts of the world in order to be the first in the field with a certain quantity of news which I cannot help regarding as meagre. Think, now, of a paper with direct cable communication through to its own office calling up New York, calling up Melbourne, at times suitable to their longitudes, and receiving direct information at the rate of speed I have indicated. Such a paper would control everything, and I have the power to make that paper, for in granting royalties I shall reserve this right as far as it applies to news. This ideal paper to my mind should have four editions appearing once every six hours. In this way I could collect from places east and west of Greenwich an instantaneous supply of news at the proper time. Our news from one-half of the world at the present rates may be 12 hours behind time because of the alternation of day and night. I should remedy that with my four editions." "And you say that this system with its extraordinary possibilities is ready for application?" "It is ready to-day. It can be applied to the syphon-recorder system, even to the Morse instrument, which you know is in many cases unworkable. This is not all. It will render submarine telephony possible, and it will admit of multiplex telephony—a thing scarcely dreamt of, much less attempted. But the crowning achievement, as I said at the beginning—and I repeat that this no Jules Verne fancy, but an accomplished fact—the crowning achievement is that for 20 words per minute in modern submarine telegraphy my invention will substitute upwards of 100,000."

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THE POTENTIOMETER AND ITS USES.

BY ELLIS H. CRAPPER, A.I.E.E.

§ 1. *Introduction.*—The potentiometer, as its name implies and in a restricted sense, is an instrument for measuring *differences of potential*, or E.M.F.'s. The essential part of this instrument consists of a long fine platinoid or German-silver wire stretched over a scale, and when in use the ends of this wire are maintained at a constant difference of potential. Since, however, the three factors—E.M.F., current, and resistance—present in an electric circuit may be expressed in terms of difference of potential, the principle of measuring differences of potential by comparison of the fall of potential along a wire with the E.M.F. of a standard cell may be quite generally applied to the measurement of the three quantities—E.M.F., current, and resistance—with very little preparation and trouble, and with excellent results. When we consider that the potentiometer is both a laboratory and a workshop instrument, that the construction is so simple that anyone may make the instrument at little cost, and that it replaces more expensive apparatus—such as the quadrant electrometer, etc.—and at the same time is easy to manipulate and perfectly reliable, one is surprised that it is not more commonly used. It is because of its almost general application in electrical measurements that we desire to draw the attention of students and electrical engineers generally to the principles applied, and to the construction and methods of using this useful measuring instrument. And here we must mention that we are indebted to Dr. Fleming and Messrs. Crompton and Co., Limited, for the introduction and development of potentiometer methods.

§ 2. It will be well here to point out in connection with

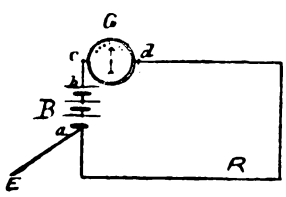

FIG. 1.

Ohm's law, as stated usually—*i.e.*, C = E/R—that E may mean the total E.M.F., or the D.P. between any two points, but in our case we propose to denote E.M.F. by E, and the D.P. between different points by e_1, e_2, e_3, etc., and the corresponding resistances between the points by r_1, r_2, r_3, etc., reserving R for the total resistance of the circuit, thus

$$C = E/R = e_1/r_1 = e_2/r_2 = e_3/r_3 = \frac{e_1+e_2+e_3}{r_1+r_2+r_3} . \quad . \quad (1)$$

From which we see that the E.M.F. distributes itself throughout a simple circuit uniformly, so that the value of C is the same throughout. Probably the distribution of the E.M.F. in a circuit can be better shown graphically than described. For an example we will consider a circuit consisting of a battery, a galvanometer, and a wire, as shown in Fig. 1, in which B is the battery, G the galvanometer, and R the connecting wire. The negative pole of B is earth connected at E.

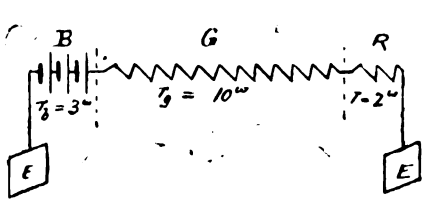

FIG. 2.

If the E.M.F. and resistance, r_b, of the battery be five volts and three ohms respectively, r_g, the resistance of G, 10 ohms, and r, the resistance of R, two ohms, the current traversing the circuit will be

$$C = \frac{5}{3+10+2} = \frac{5}{15} = \tfrac{1}{3} \text{ ampere.}$$

Fig. 2 represents the circuit diagrammatically, the circuit being closed with the earth-plates, E, an arrangement which allows us to fix upon a point of the circuit which may be considered as at zero potential. In Fig. 3 the relation between the resistance and D.P. is shown graphically. Let D.P. be shown as ordinates, and the resistance (by lengths of line) as abscissa. At A the ordinate A Y represents the E.M.F., five volts; at C, the ordinate represents four volts; since if five volts are required to send a current of $\frac{1}{3}$ ampere through the total resistance of 15 ohms, four volts will be required to send the same current through the 12 ohms resistance, in the external part of the circuit. Similarly at D the ordinate represents $\frac{2}{3}$ volt. It will then be found that by drawing a line through the points Y, C^1, D^1, the ends of the ordinates A Y, C C^1, and D D^1, the line is a straight line cutting the abscissa at A^1, which is at zero potential. The line Y C^1 D^1 A^1 thus shows the gradient in the pressure throughout the circuit.

From what has already been said, and from the geometry of the figure, it will be sufficient, in passing, to point out that Y c^1, c^1 d^1, and d^1 A represent differences of potential, and that the pressure required to send the current through any part of the circuit is given by the length of the ordinate subtended by that part of the *line of slope* corresponding to the resistance of that part of the circuit. Again, the line of slope makes an angle θ with the horizontal, from which we see that tan θ = E/R = C, and that the angles C^1 D^1 d, Y C^1 c^1 = θ. Also that $E = e_1 + e_2 + e_3$.

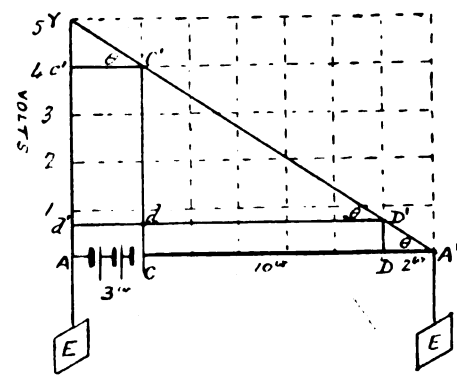

FIG. 3.

We can now deduce some very important relationships between the three factors, E.M.F., C, and R, which will be found useful later on.

1. The fall in potential along a homogeneous conductor is uniform, and directly proportional to the resistance.

2. The D.P. between any two points of a circuit is the same proportion of the E.M.F. (of the circuit), as the resistance between the points is of the total resistance of the circuit, or, algebraically, $e_1/E = r_1/R$, from $E/R = e_1/r_1$.

3. Since $C = E/R = e_1/r_1 = e_2/r_2 = e_3/r_3$ (from equation 1), therefore $E = C R$; $e_1 = C r_1$; $e_2 = C r_2$; $e_3 = C r_3$.

In practice, D.P. is often termed *fall in potential* or *drop in volts*, terms which are in perfect harmony with the results depicted in Fig. 3. The values of the D.P.'s just stated may be given in the general form:

Drop in volts = ohmage × amperage . . (2)

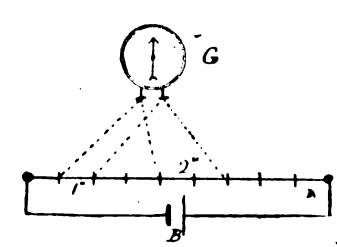

FIG. 4.

where ohmage is the value of the resistance between the two points under consideration.

The following example very clearly illustrates how the above principles may be applied in electrical measurements. A battery of one ohm resistance and E.M.F. E volts is connected to a uniform wire of nine ohms resistance stretched over a scale 9in. long. The D.P. between the ends of the wire will be 9/10 E, and D.P.'s of ·1 E, ·2 E, ·3 E, etc., will

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exist between points 1in., 2in., and 3in. apart respectively along the wire. If the battery be replaced by another of the same resistance, but of E.M.F. E^1 volts, and it is found that a D.P. between two points in the wire 2in. apart gives the same deflection with a galvanometer—the arrangement is shown in Fig. 4—as the D.P. for 1in. in the former case, then we know that

$$\frac{2}{9}E^1 = \frac{1}{9}E, \text{ or } E = 2E^1.$$

§ 3. *Construction of Potentiometer.*—The details of the construction of this instrument will be apparent from the complete sketch, given in Fig. 5, of one for universal use. Three boxwood scales, A B, C D, E F, each one metre long, and divided into millimetres, are fixed parallel to one another on a stout mahogany board, about 4½ft. long and 9in. wide. H, K, L, and M are pieces of copper ¾in. wide fastened to the board, as shown. The potentiometer wire consists of two fine uniform platinoid or German-silver wires, No. 30 B.W.G., soldered to H, K, and L, and stretched over the scales A B and C D, so that it is two metres long, and is divided into 2,000 parts by the millimetre divisions. At the ends of the scale, E F, there are two terminals, so that a wire may be stretched over the scale (shown as a dotted line) if we wish to determine its specific resistance or compare its conductivity. This will be considered later on. P*p* is a broad copper strip, upon which are soldered six terminals. N is a small switch of five or six contact-pieces, so that in conjunction with P*p* the E.M.F.'s of five or six different cells may be determined or compared without disconnecting or changing the connecting wires, simply by moving the switch arm of N. In the figure, three cells are shown connected up ready for taking measurements. S, S^1, S^2, and S^3 are sliding pieces with copper knife-edges on springs of brass for making contact with the potentiometer wire as desired. The details of these sliding pieces are shown in section at I. and II., from which the construction is apparent. In all cases the small circles indicate terminals. If required, the sliding pieces can be removed with ease, without moving the copper pieces.

§ 4. *Comparison or Determination of E.M.F. or D.P.*—The connections for making these tests are shown in Fig. 5, the additional pieces of apparatus employed not actually forming part of the potentiometer, being a battery of two or three accumulator cells or other reliable cells, if accumulators are not available, a high-resistance reflecting galvanometer, two variable resistances or ordinary resistance boxes, and a Clark standard cell, marked S.C. It will be noticed that the battery is connected to H and L, and that a contant D.P. of two, three, or four volts, as desired, may be maintained at the ends of the potentiometer wire by means of the variable resistance in circuit with the battery. Between the terminal on H and the end terminal at *p* is connected the galvanometer in series with the other variable resistance, whilst the positive pole of the Clark standard cell is connected to the other end terminal at P, thus being in opposition to the battery, and the negative pole is connected to slider S. The cells whose E.M.F.'s are required are connected with the other terminals on P*p* and the switch N, the arm of which is connected to slider S^1, as shown in the figure. As everything depends upon our standard of E.M.F., it is necessary to remember that the E.M.F. of a Clark standard cell varies with changes in temperature, and from a large number of experiments it has been found to have the following values for its E.M.F. at the following temperatures:

Temp. C.	E.M.F. (volts).	Temp. C.	E.M.F. (volts).
0	1·451	16	1·433
5	1·445	17	1·432
10	1·440	18	1·431
12	1·437	19	1·430
14	1·435	20	1·428
15	1·434	25	1·423

Everything being ready, the following is a convenient method of commencing the determinations, and to simplify matters we give the results of an actual experiment in determining the E.M.F. of a Grove's cell, which we shall assume to be represented by C^1 in the figure. It was noticed that the temperature of the room was 15deg. C., and one knife-edge of slider S was set at division 1,434 on potentiometer wire—*i.e.*, 1,434mm. from A—1·434 volts being the E.M.F. of the standard cell for 15deg. C. Then the resistance in the battery circuit was varied until the galvanometer gave no deflection, when the knife-edge made contact with the wire, and the battery closed by the key K^1.

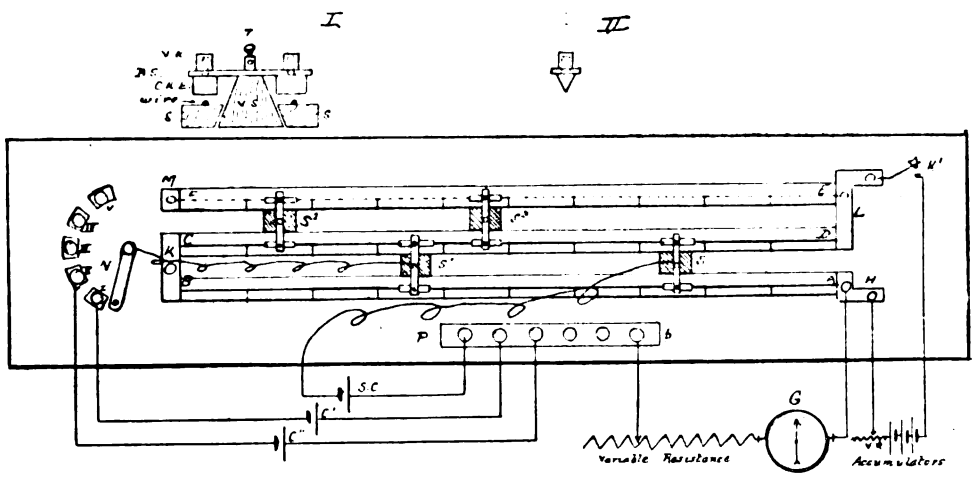

FIG. 5.

T, Terminal. V K, Vulcanite Knob for pressing knife edges down. B S, Brass Spring. C K E, Copper Knife Edge. S, Boxwood Scale. V S, Vulcanite Slider, shaped to slide easily between the scales.

The fall of potential along the wire between A and S was now 1·434 volts, because the E.M.F. of the standard was 1·434 volts; consequently, we knew the D.P., or drop in volts, between A and D was two volts, the 2,000mm. divisions corresponding to two volts. The knife-edge of S was now released, and the arm of N placed on contact-piece I., to put cell C^1 in circuit, and the position of the slider S^1 ascertained when the galvanometer gave no deflection under similar conditions as before. In this case it was found to be at division 1,760, so that the E.M.F. of the Grove's cell was 1·76 volts. In the same way the E.M.F. of other cells may be determined by simply using the slider S^1, by moving the arm of N into contact with the contact-piece connected to the cell under test. Throughout the test the slider S is only used with the standard cell.

It is important to notice that the mean of a number of determinations should be taken, during which it is advisable to repeatedly put slider S down to see if the battery is keeping constant. If not, the resistance in the battery circuit should be varied so as to keep the D.P. between A and D two volts. With care and practice a large number of tests can be made in a very short time, since there is no disconnecting and changing connecting wires. In all cases a high resistance must be inserted in the galvanometer circuit, so that the standard cell does no work. The accuracy of the results may be increased by insulating the battery, galvanometer, and potentiometer on sheets of indiarubber.

(To be continued.)

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SOME USES OF CURVES IN ELECTRICAL PRACTICE.

BY H. H. SIMMONS, A.I.E.E.

(Continued from page 119.)

Since one meets in practice so far more commonly with such straight lines as these, which do not pass through "the origin," as the point O is called, it will be well to look at another way of arriving at the equation to such straight lines. Take, for instance, the line N R P T in Fig. 8. We were content with the evidence of the three curves in Fig. 6 as showing that all straight lines through the origin were represented by an equation of the shape $m x = y$, and the difficulty here is that this line does not pass through the origin which we have taken. Let us, then, take a new origin, say the point N. If this is our

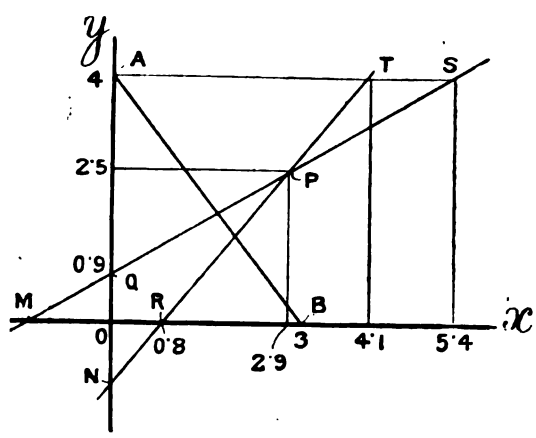

FIG. 8.

origin, we have to measure all distances from this point along our axes, and we have a new axis, which we will call $O^1 X^1$ (Fig. 9). and the point O^1 and the point N are the same, and $O^1 X^1$ is parallel to O X. Obviously all our x measurements are still the same, but all our y measurements must be increased by the length O N or O O^1. These new y measurements we will call y^1, and in all cases $y^1 = y + O O^1$. The distance $O^1 L = O L + O O^1 = O L + 0{\cdot}971$, and the distance $O^1 V = O V + O O^1$.

Point.	x	y	y^1	$\frac{y^1}{x}$
N	0	−·971	0	—
R	0·8	0	0·971	1·214
P	2·9	2·55	3·521	1·214
T	4·1	4	4·971	1·214

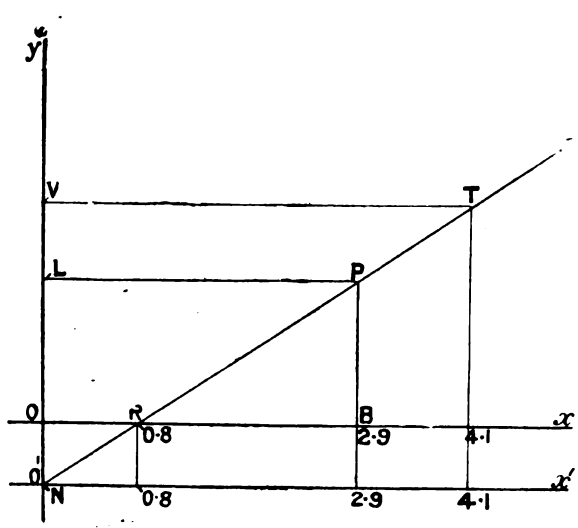

FIG. 9.

And see that $1{\cdot}214 x = y^1$; but $y^1 = y + O O^1$ and $O O^1$ is the same as O N. Now, O N is the Y ordinate of N, and is 0·971, so $1{\cdot}214\ x = y^1 = y + O\ N = y + 0{\cdot}971$; $\therefore\ 1{\cdot}214 x - 0{\cdot}971 = y$, which is what we had above, and the point N is the point where our curve cuts the axis of Y, which value of y we called h.

This expression $m x + h = y$ is known as the general equation to a straight line. We have seen that the equation $x = y$ will represent one particular straight line, but only one; and that $y = m x$ will represent any straight line which passes through O, but that if the straight line cuts O X or O Y not at O we must modify this equation $m x = y$, as we have shown, into $m x + h = y$. Now, this equation $m x + h = y$ fits all the straight lines, for, of course, h may = 0 and m may = 0, for these letters must have any value which will fit the equation to the line. If $m = 0$ and $h = 4$, we find that $m x + h = y$ is the straight line A T S, Fig. 8. The line of which B P is a part is $x = 2{\cdot}9$, for being parallel to O Y it can have any value for y—there is no value of y which cannot be put to this line, but it has only one x value; in this case m is really infinity, and h becomes minus infinity. The values for m and h, in the case of the straight lines M Q P S and N R P T, have been given before.

The object of mentioning all these cases is to make clear that x and y are the variables, but that m and h are arbitrary constants, and we write these letters m and h simply to imply that each curve needs a particular value in their places to make the equation fit it. It has been explained in a previous article that the use of the variables x and y is to indicate that we may give any value we like to one of them, and by simple arithmetic and the use of the values in the places of m and h can calculate the value of the other variable for this value of the first variable. In this way, if we are given the equation to a curve of any description, we can at once find points on it by choosing values to give to one variable—say, x—and then calculating the corresponding values for y.

It may not be superfluous to remark here that for the purpose of plotting curves a special ruled paper, known indifferently as "squared" or "sectional" paper, is sold, and of a quality sufficiently good for most purposes can be purchased at ½d. a sheet (18in. × 10in.).

It is certainly not unnecessary to repeat that *nothing* so thoroughly brings home to the mind the effect of varying the values of m and h as actually plotting curves, using the equation $m x + h = y$, and trying a pair of values for m and h. Then give m a different value and again plot the curve. Do this with several values of m, keeping h the same. Now keep the value of m constant and plot the curve, giving various values to h—for every value you give to h plot a curve. Doing this, though a somewhat monotonous exercise, will make the whole thing clearer than hours of reading or lecturing could possibly do.

It would be well to plot such curves as are represented by the following equations,

$$x = m y^2\ ;\ x^2 = m y\ ;\ x = \log y\ ;\ \frac{x}{a} + \frac{y^2}{b} = 1,$$

using m, a, and b to represent arbitrary constants, as before, and x and y as the variables.

Erratum in last article.—Page 118, three lines below Fig. 8, should read: "here $x = -1{\cdot}58$, m must = 0; now we saw that m meant."

(To be continued.)

NOTES ON HYDRAULIC POWER SUPPLY IN TOWNS—GLASGOW, MANCHESTER, BUENOS AYRES, ETC.*

BY EDWARD B. ELLINGTON.

(Concluded from page 125.)

Comparison of Hydraulic and Electric Power Supply.—It is interesting, therefore, to enquire whether there are any grounds for the assumption that hydraulic power obtained otherwise than from a natural head of water can be used economically for generating an electric current. It so happens that the materials are available for a comparison between the cost of a public supply of hydraulic power and that of electricity obtained from a central station on almost exactly the same scale. The particulars given in

* Paper read at the meeting of the Institution of Mechanical Engineers at Glasgow.

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TABLE II.—Comparison of Hydraulic Power Supply and Electric Supply, Compiled from the Reports of the London Hydraulic Power Supply (L.H.P.) and the Westminster Electric Supply (W.E.S.) for the Year 1894.

1894.	Totals. L.H.P.	Totals. W.E.S.	At gallons at 1,730ft. head. L.H.P.	At gallons at 1,730ft. head. W.E.S.	At Board of Trade electric units. L.H.P.	At Board of Trade electric units. W.E.S.
	£	£	Gallons.	Gallons.	Electric units.	Electric units.
Capital outlay	471,552*	411,018	—	—	—	—
Output	—	—	400,313,000	396,256,000	2,609,240	2,582,801
Quantity sold	—	—	332,390,000	333,430,000	2,166,520	2,173,298
Received for supply	49,237	50,729	—	—	—	—
Average price obtained	—	—	Per 1,000 galls. 35·55d.	Per 1,000 galls. 36·51d.	Per unit. 5·45d.	Per unit. 5·6d.
Station costs.	**Totals.**		**At 1,000 gallons at 1,730ft. head.**		**At Board of Trade electric unit.**	
	£	£	d.	d.	d.	d.
Coal	3,276	5,842	1·964	3·539	0·301	0·543
Oil, water, and engine-room expenses	1,351†	1 228	0·810	0·743	0·124	0·114
Salaries and wages	3,071	6,345	1·841	3·839	0·282	0·589
Repairs and maintenance	929	1,478	0·557	0·893	0·086	0·137
Totals	8,627	14,893	5·172	9·014	0·793	1·383
Individual station	Wapping.‡	Davies-st.§	Wapping.‡	Davies-st. §	Wapping.‡	Davies-st.§
	£	£	d.	d.	d.	d.
Coal	1,242	3,263	1·684	3·906	0·258	0·600
Oil, water, and engine-room expenses	385	600	0·522	0·718	0·080	0·110
Salaries and wages	1,072	2,500	1·453	2·993	0·223	0·459
Repairs and maintenance	382	931	0·518	1·114	0·079	0·171
Totals	3,081	7,294	4·177	8·731	0 640	1·340

* Including £56,000 for new site and station, started October, 1894. † Including £400 for water rights and £129 for gas lighting. ‡ Wapping station only; output 177,000,000 gallons in 1894. § Davies-street only; output 1,306,794 units in 1894, equivalent to 200,490,000 gallons.

Table II. are taken from the records of the London Hydraulic Power Company and of the Westminster Electric Supply Corporation for the year ending December 31, 1894. In making the comparison, 1,000 gallons of water at 750lb. per square inch is taken as equivalent to 6·518 Board of Trade units of electricity. This analysis shows that the station cost of the hydraulic power is 5·172d. per thousand gallons pumped at the pressure of 750lb. per square inch; while the corresponding cost of an equivalent amount of electric energy reduced to the same hydraulic standard is 9·014d. per thousand gallons; or on the electrical standard of Board of Trade units, 0·793d. and 1·383d. respectively. The output during the year, the capital employed, and the average rate received for both supplies, are nearly the same. The coincidence of the figures is extraordinary, except in the cost items, in which their divergence is equally remarkable. No other conclusion can be drawn than that for some reason or other not hitherto explained hydraulic power is much less costly to produce than electricity. The Westminster electric supply is one of the largest in the country, and its cost is one of the lowest. The London hydraulic supply is the greatest anywhere, and is produced no doubt very cheaply. In neither, however, has the minimum cost been reached, for in both of them the station cost in the newer installations is considerably below the average for 1894. For instance, the station cost of the hydraulic power supply from the Wapping station for 1894 was only 4·177d., as against 5·172d. for the whole supply; while the station cost of the Davies-street station of the Westminster electric supply is equivalent to 8·731d. per 1,000 gallons as against 9·014d. for the whole supply. It may be thought that the low annual load-factor of, say, 0·18 for the electrical supply, as against 0·33 for the hydraulic, accounts for most of the difference; but under the able control of Prof. Kennedy the influence of a low load-factor has been to a great extent neutralised by running the machinery actually in use at nearly full load. Moreover, the figures of other electric installations, such as the St. James's and Pall Mall, where the load-factor is much higher than in the Westminster district, show a similar difference of cost as compared with the hydraulic supply. Now it is obvious from the figures of the London and Westminster installations that, as the output during the year was the same, while there is so great a difference in the annual load-factor, the maximum horse-power employed is much greater for the electric than for the hydraulic supply; but the output per unit of capital outlay seems to be much the same. This is no doubt owing to the greater concentration of demand in the area supplied with electricity. If a large amount of power is concentrated in a single station, it is practicable to work that station much nearer to its maximum capacity than if the same power had to be supplied from two or three stations. In the London hydraulic supply, while the annual load-factor is 0·33, calculated on the maximum delivery at any time during the year, the load-factor of the whole plant in use during the year under the most favourable conditions is only 0·20, and is often much lower; in other words, more than one-third of the whole plant is always in reserve, and in some years as much as half. The proportion of plant out of use altogether or not running at full load at the periods of maximum demand is no doubt much less at most electric lighting stations, and the load-factors of the two systems calculated upon the total station plant probably do not differ widely. The fact that the load-factor calculated on the maximum flow is lower for the electric supply than for the hydraulic does not, other things being equal, account for the larger part of the difference of cost. This is shown also by a comparison of the cost of the hydraulic supply during a week when the output is large and during another when it is small. During the week ending October 18, 1894, altogether 9,095,000 gallons were pumped at the London hydraulic power stations, and during the week ending December 27, 5,902,000 gallons only. The increased cost for fuel in the latter week was 0·317d. per 1,000 gallons, and for wages 0·77d. per 1,000 gallons, making 1·087d. per 1,000 gallons; whereas the average excess cost of the electric supply is more than 3½ times as much, and in the item of coal nearly five times as much. The immediate question, however, is the economy of using hydraulic power for generating electricity; and it will be seen from the foregoing figures that, with a loss of 33 per cent. of the hydraulic energy during conversion into electric energy, the station cost of 0·793d. per Board of Trade unit would rise to 1·189d., or 0·194d. below the cost 1·383d. of the direct current of the Westminster supply. The cost will be further increased by the wages, superintendence, and repairs at the converting stations; so that on the whole there does not seem much probability of any economy resulting from this method of generating electricity on a large scale. It

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may be mentioned that the principal reason which led the late Prof. Van Rysselberghe to advise the combined method for the electric supply of Antwerp was that he considered the losses of distribution of the electric current would be much less on that method. The losses of distribution, however, are not very serious either way; and the direct or the combined method must ultimately stand or fall, the author considers, on the relative generating cost per unit. Mr. L. Moris has kindly furnished the particulars in Table III. of the working of the Antwerp hydraulic service. The very low cost per thousand gallons pumped is evidently due to the small amount of wages paid at the central station, and the figures include nothing for superintendence, water supply, lighting of station, removal of ashes, or repairs to machinery. At least 1½d. per thousand gallons should be added for these items in order to make the cost comparable with that of the London stations. It will be noticed that the reduced output in April increased the cost only 0·46d. per thousand gallons, or, say, 15 per cent., while the output was only 58 per cent. of that in January. It seems, however, that notwithstanding the low cost at which the hydraulic supply is obtained in Antwerp, the general results of the combined method during the first nine months of working have not been satisfactory. It is stated that the arrangements have proved more costly than the usual direct method, not only in first cost, but in working expenses. The capital outlay per electric unit would probably be greater, but there seems no sufficient reason why the working expenses should be increased. Further information is required before an explanation can be given. While the combined method does not seem to have any sufficient basis for a general system of distribution, it is evident from the foregoing figures that electricity can be economically generated by means of hydraulic power artifically obtained; and the latter can therefore be used with advantage as a supplement to ordinary methods of generating electrical energy. Hydraulic power is clearly much the most economical in those applications where the direct pressure can be utilised—such as for lifting and pressing. Where rotary motion is needed, the special circumstances of each case will determine what power shall be used, and all are now more nearly on a par as regards cost. For motors running regularly for several hours a day the London hydraulic power stations now supply power at a rate of 1s. 6d. per 1,000 gallons, which is equivalent to 2·76d. per Board of Trade unit of electricity, or, say, 3d. per brake horse-power per hour. It is questionable whether small powers can by any means be obtained at a lower rate when all the items of cost are taken into account.

TABLE III.—Antwerp Hydraulic Power Service.

1895.	January to April. 4 months.	January. Maximum month.	April. Minimum month.
	Gallons.	Gallons.	Gallons.
Quantity pumped	59,080,000	20,178,000	11,772,000
	Pence.	Pence.	Pence.
Station cost per thousand gallons.			
Coal	2·618	2·483	2·614
Engine-room stores	0·118	0·130	0·134
Wages	0·693	0·512	0·840
Total	3·429	3·125	3·588

Hydraulic Power Supply for Drainage.—Hydraulic power mains have recently been put down in the streets of Buenos Ayres for the purpose of drainage, and although the supply is not intended to be sold to the public, yet the conditions are such as to render interesting a general outline of the undertaking as an instance of a hydraulic power supply in towns. As engineer-in-chief to the works, the Hon. R. C. Parsons had a few years ago to face the problem of draining the two low-lying Boca and Barracas districts. In order to avoid the great cost and difficulty of laying deep sewers, he ultimately decided to lay out the works on the plan of numerous small automatic pumping stations, and finally adopted hydraulic power as the best means for working the pumps at the sumps. There is a central station, containing two compound surface-condensing horizontal engines, having cylinders 15½in. and 27in. diameter with 22in. stroke; each engine works direct a double-acting pump of 5in. diameter and 20in. stroke, and is capable of delivering 175 gallons of water per minute at 58 revolutions. Space has been provided for a third engine, whenever the work to be done at the sumps renders it necessary. There are three Lancashire boilers, 6ft. diameter by 22ft. long, with a Green's economiser of 120 tubes. The roof of the engine-house is a tank, which is kept supplied from the waterworks mains. The water after use is run to waste into the sewers. The engines can be run with or without the condensers, as it is sometimes inconvenient to use the water in the tank for condensing purposes, owing to the high temperatures during the hot season. There are two accumulators of 18in. diameter and 20ft. stroke, which were loaded at the trials to 800lb. per square inch; but the machinery is calculated to work at 750lb. per square inch under ordinary conditions. The station is fitted out with the usual accessories. The mains carried through the Boca and Barracas districts are nearly 8½ miles in length. There is a duplicate supply to every sump. The largest mains are 5in. bore, and the smallest 2in. bore. There are in all 17 sumps. Each sump contains duplicate hydraulic sewage pumps on the author's system. The quantity of sewage to be dealt with varies considerably at the different sumps, but it was found practicable to reduce the whole of the pumps to two sizes, and as a matter of convenience the only substantial difference between them was made in the stroke. They are all single acting, and have plungers 30in. diameter; 22 of them are made with 3ft. stroke, and 12 with 4ft. stroke; the maximum speed of working is 10 double strokes per minute. The head of water and friction on the delivery sewers are also different at the different sumps, and the diameter of the hydraulic working rams was varied to suit. The pressure on the side rams, which perform the up stroke, is constant; the water from these rams is returned in the down stroke to the central hydraulic cylinder. The sewage runs into the sumps by gravity, and when they are nearly full a float starts one of the pumps, and when the level falls a certain amount the float stops the pumps. If the level of sewage continues to rise after the first pump is at work, another float starts the second pump. The pumps therefore always work so as to cause a flushing velocity in the rising main or sewers. The exhaust power water is discharged into the sewage-pump cylinders, thus serving to dilute the sewage and keep the plungers clean. The whole arrangement is automatic. At the time the machinery was completed, there were no houses connected to the sewers, so that the tests had to be made with water run into the sewers for the purpose; the results of the engine tests are given in Table IV. The delivery sewers discharge at different points into the main outfall sewer, which is everywhere above the level of the Boca and Barracas drainage area. The whole of the mains were tested to 1,500lb. on the square inch after being laid. In laying them during the hot weather it was found necessary to protect them from the heat of the sun, in order to preserve their correct length. The whole of the work, including all the mains, was prepared in such a way that it was unnecessary to obtain any making-up pieces in Buenos Ayres, and all the machinery for each sump was erected in the workshops at Chester before being sent out.

It will be seen from Table IV. that the coal per indicated horse-power was 1·891b. per hour, and per pump horse-power 2·291b. per hour. Taking the average efficiency at the sewage pumps at 50 per cent.,* including all losses in the mains and valves at the highest speed contemplated, the expenditure of coal is 4·581b. per pump horse-power at the sumps. This shows that 41 per cent. of the indicated horse-power of the engines is recovered in useful work at the sumps. The pumps have to work under most variable conditions, and are situated at 17 sumps distributed over an area of nearly two square miles, requiring over eight miles of mains to connect them with the central station. The economy to be obtained under such circum-

* The actual efficiency of the pumps with the higher lifts of 20ft. to 28ft. was considerably more; but at the lower heads of 10ft. to 15ft. the efficiency was necessarily reduced.

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TABLE IV.—Hydraulic Power Supply for Drainage in Buenos Ayres. Trials of Two Compound Horizontal Condensing Pumping Engines at Central Station.

November 21-22, 1893.	Engine No. 1.	Engine No. 2.
Duration of trial, hours	10	10
Diameter of high-pressure cylinder	15½in.	15½in.
Diameter of low-pressure cylinder	27in.	27in.
Stroke	22in.	22in.
Revolutions, total during trial	35,150	35,030
Revolutions, average per minute	55·58	58·38
Indicated horse-power, mean	119·131	120·757
Water pumped at 800lb. pressure per square inch, total during trial, gallons	106,293	105,931
Water average per minute, gallons	177·15	176·55
South Wales coal feed into furnaces, total during trial, ash, etc., not deducted, pounds	2,354·61	2,192·47
Coal per indicated horse-power per hour, pounds	1·97	1·81
Coal per pump horse-power per hour, pounds	2·37	2·22
Boiler pressure per square inch above atm., pounds	100	100

stances cannot be great, and it is believed that no other method of distribution has shown such good results under similar conditions. The Hydraulic Engineering Company, Chester, were the contractors for the construction and erection of the whole of the plant; Mr. F. W. Thornton had charge of the erection of the machinery and laying of the mains for them. Hydraulic pumps of the same kind as those at Buenos Ayres have been for some years at work, pumping the water from the River Thames into the reservoir tanks at the London Hydraulic Supply stations. At Falcon Wharf, Blackfriars, the head is about 80ft., including friction in the rising main; and the efficiency of the pumps is 75½ per cent.

THE BEHAVIOUR OF TRANSFORMERS UNDER THE INFLUENCE OF ALTERNATING CURRENTS OF VARIOUS PERIODICITIES.

This was the title of the paper which Dr. G. Roessler, of Berlin, read at the recent meeting of the Verband Deutscher Elektrotechniker at Munich. The paper is a very elaborate one, and is elucidated by numerous tables of figures and diagrams. The author says that the general definition of an alternating current as an electric current whose strength periodically alters is only a half definition, since the general formula which describes each periodical variation consists of a number of sines, and its determination for every special case of an alternating current differing from the sinus kind offers difficulties, and it has been usual to solve all alternating-current problems under the supposition of a pure sinusoidal flow of the alternating current. This process is only justified if by the experiment and by theoretical consideration it is shown that deviations from sinusoidal variations do not substantially affect the behaviour of the alternating current in its technical applications. To what extent such an influence exists is, however, a question still unanswered.

Three items for the technical application of the alternating current come into consideration: lamps, transformers, and motors. As to lamps, in regard of incandescent lamps it is not questionable, according to the action of the current, that independent of the curve of the alternating current the same illuminating power results if the average value of the quadrates of the current intensity is the same. In respect of arc lamps, the influencing of the illuminating power by the form of the current curve required a special investigation. The author reported at the previous meeting of the Verband upon a number of measurements which endeavoured to frame a reply to his question. They manifested that the illuminating power of alternate-current arc lamps is very considerably dependent on the nature of tension and current curves, so that the illuminating power is greater in proportion as the alternating current retains its maximum value, and therefore the flatter the current curve is.

Regarding the influence of the periodical ebb and flow of the alternating current on the action of transformers and motors, opinions are still very much divided. It was in view of this difference of opinion on a matter of importance to those interested in alternating currents that the author conducted a series of experiments with an alternate-current transformer in the electrical laboratory of the Technical High School in Berlin, which experiments he describes in detail in his paper. The current for feeding the transformer was supplied by two alternate-current dynamos, also in the laboratory, which were especially adapted for the investigations, because one of them gave a very pointed tension curve, while the curve of the second was almost sinusoidal.

The first is a four-pole 5·5-kilowatt machine, by Ganz and Co., with revolving magnet cross; the second, an old small 480-watt machine, by Wechlser and Co., with four poles on each side of the four-coil revolving armature. For the comparative investigation with both machines, only an old 480-watt transformer could be chosen on account of the inferior capacity of the smaller of the laboratory transformers. This old small transformer does not, of course, represent the present stage of transformer construction. The iron core consisted of 78 E-shaped wrought-iron plates 0·5mm. thick. The plates lay alternately inversely upon one another and were insulated by silk paper. They were held together by a wooden frame. The total weight of the plate was 8·168 kilogrammes. The primary coil consisted of 132 turns of 2·7mm. copper wire; the secondary of 265 turns of 1·8mm. copper wire. For estimating the primary and secondary tensions, Cardew voltmeters were used; for measuring the primary pressure a Thomson instrument was employed; for the secondary, a Siemens and Halske electrodynamometer. The primary effects were given by a Helios wattmeter, while the secondary capacity, as the load of the transformer was exclusively through incandescent lamps, was obtained by multiplication of the values for the secondary tension and the secondary pressure.

In summing up the experiments, the author says: There remain (1) the difference of the losses of effect in the iron, as these only depend on the value of the primary tension and their frequency; (2) the variation of the primary pressures, even if the secondary current has phase retardation against the secondary tension; (3) the ground for the differences of the magnetic dissemination is independent of the nature of the resistance in the secondary circuit, and therefore a difference of the fall of tension in the same sense by loading with induced resistances is also to be expected. It is shown that the use of peaked tension curves, so far as relates to effect-consumption and the value of the primary pressures, supplies much more favourable results than the use of sinus lines or of still flatter curves. Against these great advantages of pointed tension curves is, however, to be placed a disadvantage in the shape of the large secondary loss of tension. The percentage variation of this fall of tension was in the case under notice much less than the variation of the primary pressures and effects, and may therefore be no great obstacle to the use of peaked curves if several transformers work on a specially-arranged secondary network, whose tension is automatically regulated direct from the central station.

On the whole, the author thinks that the superiority of the one or the other machine must be decided by the load diagram of the installation and the transmission distance. If short-distance work, which during the greater portion of the day only reaches a small portion of its maximum value, be in question, as in the case of a central station near a town which distributes power and light to many consumers, the use of peaked tension curves presents the probability of great economy. For power transmission to long distances, on the other hand, the use of flat tension curves will be more advisable. These results refer to the behaviour of transformers alone. The inferior illuminating power of arc lamps with peaked curves sinks the scale more to the side of the flat curves. But to arrive at a definite conclusion upon every point, Dr. Roessler adds, we must have the results of the investigations of the behaviour of motors.

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IRON AND STEEL INSTITUTE.

In our issue of the 5th ult. we gave a list of the papers which are to be read at the autumn meeting of the Iron and Steel Institute, which will take place in Birmingham on the 21st, 22nd, and 23rd inst. The following additional papers will also be read: "The Production of Iron by a New Process," by Mr. R. A. Hadfield; "The Iron Industry of the South of Russia," by Mr. George Kamensky; and "The Analysis of Ferro-Chromium," by Mr. E. H. Saniter. These make the total number of papers thirteen. The outline programme for the meeting is as follows: Monday, August 19.—The secretaries' office will be open from 2 p.m. to 6 p.m. in the Council House, Birmingham, for the registration of addresses, issue of badges of membership, programmes, invitation-cards, etc. Tuesday, August 20.—9 a.m., secretary's office open in the Council House, meeting of council in committee-room; 10 a.m., reception of the president, council, and members of the institute by the Mayor of Birmingham and the members of the local reception committee, reading and discussion of papers; 12.30 p.m., adjournment for lunch; 2 p.m., visit to industrial establishments in or near Birmingham, the list including the following alternative excursions: (*a*) to the works of the Electric Construction Company, Wolverhampton, and of the Great Western Engine Works, Wolverhampton; (*b*) to the works of Messrs. Thomas Parker and Co., electrical engineers, Wolverhampton, and of the Staffordshire Steel and Ingot Iron Company, Bilston; (*c*) to the surface works of Hamstead Colliery, Birmingham; (*d*) to Tangye's Engineering Works, Smethwick; (*e*) to the works of Messrs. Baldwin and Sons, paper manufacturers, King's Norton, or (*f*) members not taking part in the foregoing excursions may visit Messrs. Elkington's electro-plating works, Messrs. Gillott's steel pen works, Messrs. F. and C. Osler's glass-works, the municipal gasworks (Windsor-street 9 a.m. to 11 a.m., Duddeston Mill-road, Saltley, 11 a.m. to 1 p.m.), the works of Messrs. J. Hardman and Co., stained-glass and church decoration work, the works of Messrs. J. Cartland and Sons, brassfounders, and the works of the Birmingham Electric Supply Company, 4 p.m.; 8 p.m., conversazione and reception in the City Council House and Art Gallery by the Mayor of Birmingham. Wednesday, August 21.—10 a.m., reading and discussion of papers; 12.30 p.m., adjournment for lunch. The afternoon will be devoted to—(*a*) An excursion to Worcester, where the Guildhall, the cathedral, and the works and museum of the Royal Porcelain Company will be visited. There will also be alternative excursions: (*b*) to the Earl of Dudley's Round Oak Iron and Steel Works, Limited, Brierley Hill; (*c*) to Webb's gasworks and local fireclay works at Stourbridge; (*d*) to the Birmingham Small-Arms Factory, Small Heath, and to the Government Small-Arms Factory, Sparkbrook, or (*e*) on application to the secretary, arrangements will be made for members who desire it to visit on this day Sandwell Park Colliery, the wagon works of Messrs. Brown, Marshalls, and Co., Limited (Adderley Park, Birmingham), the works of Messrs. Taylor and Challen, engineers, Birmingham, or the revolver works of Messrs. Philip Webley and Sons; 8 p.m., entertainment in the Botanical Gardens, Edgbaston, by invitation of the local reception committee. Thursday, August 22.—10 a.m., reading and discussion of papers; 12.30 p.m., adjournment for lunch. The afternoon will be devoted to an excursion to Stratford-on-Avon, under the direction of Sir Arthur Hodgson, K.C.M.G., chairman of the trustees for Shakespeare's birthplace. The members joining the excursion will visit Shakespeare's birthplace, the Shakespeare Memorial Buildings, Holy Trinity Church, and King Edward's Grammar School. They will afterwards, by invitation of the local reception committee, have tea in the Stratford Town Hall, and at 7 p.m. there will be a short entertainment consisting of Shakesperian recitations in the Memorial Theatre. The train will return to Birmingham about 8.30 p.m. Friday, August 23.—The members and ladies accompanying them will leave Birmingham by special train to visit the ruins of Kenilworth. They will then proceed to Warwick, where they will have lunch, and in the afternoon they will be received at Warwick Castle by the Earl and Countess of Warwick, who have invited them to tea. The museums and laboratories of Mason College will be open to inspection by members under the guidance of Mr. W. G. McMillan, lecturer on metallurgy, on August 20, 21, and 22, from 9 a.m. There will also be shown there a special collection, illustrating local industries, comprising raw materials, and finished or semi-manufactured goods, illustrative of the processes used.

THE ELECTRIC LIGHTING OF WIMBLEDON.

In accordance with the instructions of the Wimbledon District Council, Mr. A. H. Preece has prepared an elaborate report with alternative schemes for lighting the streets of the town with electricity, and for the general supply of electricity to the district. The report is as follows:

It cannot now be urged that electric lighting is in its infancy, or that it has not been carefully considered by those towns which have adopted it. You yourselves, when a Local Board, had the question frequently before you after my father first gave you a report on the question in 1884. Town Councils and other local bodies have for many years been considering the matter, and few of them have decided to do other than establish their own stations, while many of those who have transferred their powers are now doing their utmost to purchase them back to prevent the companies from establishing in their districts powerful monopolies and large dividend-bearing concerns. As an example, I may instance Liverpool and Manchester. The Liverpool Corporation allowed a company to start which they are now going to buy for about £400,000; this is about 50 per cent. on the shares, although the business has only been started on a large scale three or four years. Manchester was more far-seeing, and they are now with a capital expenditure of £150,000 making an annual profit of £4,000, which is increasing at a marvellous extent; while Brighton, with a capital expenditure of £119,382 made last year a profit of £4,500 after paying interest and repayment of loan.

It is interesting to note that no less than 42 towns have now established central stations for the supply of electricity, while over 30 more are actively engaged in establishing similar works. Among others, I should mention small towns such as Bootle, Burton, Burnley, Dewsbury, Yarmouth, Whitehaven, Kingston, Ealing, Cheltenham, Nelson, Taunton, Abergavenny, Basingstoke, Chichester, Eccles, Llanelly, Monmouth, Tunbridge Wells, etc. The capital invested by corporations in electric lighting now exceeds £2,500,000, and every week one may read in technical papers of Local Government Board enquiries being held for new loans and for extension loans. Most of the towns mentioned above have lighted some of their principal streets with electricity, but they have nearly all been contented with installing a few large arc lamps. The only town which has lighted its streets entirely with arc and incandescent lamps is Whitehaven, but other towns have allowed local companies to do so at fixed prices per lamp. At Whitehaven it has been a most marked success financially. Their last year's figures showed that the cost had been less than gas, and the estimated figures for this year show a profit. Portsmouth lights its streets with arc lamps up to midnight, and then incandescent lamps are lighted. Their figures for the short time they have been running are extremely good.

The proper and good illumination of the streets is the function of the local authority. It facilitates locomotion, it adds to the security of premises, it aids police supervision, it prevents accidents, and where a general supply of electricity to consumers is installed it greatly facilitates business. It is frequently said that a town which establishes an electric light station is fostering an industry which solely benefits the wealthier class; but if the streets are well lighted all classes are benefited, and everyone expresses an interest in the undertaking.

I think it is universally considered that the streets, at any rate the main streets, of Wimbledon, require better illumination. Oil lamps are undoubtedly cheap, and therefore if you are to improve the lighting it must be borne in mind that it can be done only by a somewhat larger expenditure. If you added oil lamps of larger power or if you increased the number of lamps, your annual expenditure on lighting would naturally be larger. I therefore ask you to bear in mind that if the lighting of your streets by electricity is to be done, it must be well done, and you must be prepared to expend more money per annum in so doing. I hope, however, to be able to show that by adopting electricity the cost of lighting your streets will not be so great as if you increased your oil lamps or if you had gas, while, by the aid of private lighting, which is undoubtedly wanted by many shopkeepers and residents, you will be able to materially reduce the cost of the street-lighting by placing the profit made in the private lighting to the credit of the cost of the street-lighting. This is undoubtedly a perfectly fair mode

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of procedure. The shopkeepers and owners of large private houses are those who generally require good street-lighting. The former like it so that their customers may be induced to use the streets at night, and the latter want it to be able to drive safely about late at night to their friends' houses.

The present cost of lighting by oil averages £2. 9s. 6d. per lamp, and there are about 725 lamps placed in your streets. The total cost of lighting is thus approximately £1,800. If gas were installed in place of oil the cost would be, according to Mr. Cooper's report to your committee, about £4. 11s. 7d. per lamp ; therefore the total annual cost would be about £3,320. But it must be recollected that the gas company refuse to supply lamps more than 100ft. away from existing mains unless the cost of connecting them is defrayed by the Council. This would be the case with quite 200 lamps, and it would necessitate a heavy new capital expenditure.

I understand that it is the wish of many members of your Council that two schemes should be considered—one embodying the lighting of the whole district, and the other the lighting of only the main streets. In both schemes you are bound to consider the demand for private lighting. This is, of course, only guesswork, and I have only the experience of other towns to work upon. It is interesting to note that in every town I have been connected with, the demand for current always rises where least expected. But it is certain that lamps will be thickest where shops are situated, and also that the residents in the larger houses will be the first to adopt electricity. The scheme, whether for a small number of lamps or a large number, will necessitate establishing a generating station in a cheap and convenient position. It was necessary to fix this before any estimate could be prepared. I have carefully considered the question of site, and I find that the sewage farm is practically the only suitable ground. It is somewhat distant from the centre of Wimbledon, but by placing it so far away it is not likely to be a nuisance. There is plenty of land, available water is abundant, and it will be possible to use condensers and thus save 25 per cent. on the coal bill. Again, there is already an engineering staff there, which can be added to, and the whole used to run the sewage pumps and the electric light engines, etc., and thus materially reduce the expenses. I have therefore in my estimates assumed that the generating station will be at the sewage farm. In the two schemes I submit I have only estimated for incandescent electric lamps. I cannot recommend the arc lamp for the general lighting of your streets. Arc lighting is the proper lighting for crowded city streets, and as an advertisement to the electric light. But it is too brilliant and too expensive for country roads. However, if it is desired to place a few arc lamps in the Broadway, or in Hill-road, or High-street, it can easily be done. The same mains will do for the purpose. But it will be necessary to spend a little more money both in capital and maintenance. The fixing of an arc lamp will cost about £25, including the pillar. The maintenance will be from £16 to £20 per annum, according to the number of hours it is in use.

In the scheme for lighting the whole parish I have estimated for 1,000 lamps of 32 c.p. for the public lighting, and 5,000 lamps of 8 c.p. for the private lighting. The public lamps can be of any size providing that the total number installed does not exceed the equivalent to 1,000 32-c.p. lamps. I recommend that in the main streets—such as the Broadway, Hill-road, and High-street—50-c.p. lamps, or two 32-c.p. lamps, should be fixed in each of the small posts, and in the larger posts either one 100-c.p., two 50-c.p., or three 32-c.p. lamps should be placed. But at midnight (and I have estimated for this in the mains) half of the lamps would be turned out. This can easily be done by the simple turning of a switch placed at some convenient spot. As regards the private lighting, I have estimated for 5,000 8-c.p. lamps fixed in private consumers' premises. The total number of these lamps burning at one time is not likely to exceed 3,000, and the plant provided will provide for this demand. The following are the streets in which I have allowed for private consumers : The Broadway, Merton-road, Hartfield-road, part of Haydon's-lane, Worple-road, Hill-road, High-street, Ridgway, Copse-hill, Park-side, South-side, Church-street, Arthur-road, and Wood-side. Specially heavy mains have also been provided for the shop areas in the Broadway, Merton-road, Hill-road, and High-street. This scheme, briefly summarised, shows that with a capital expenditure of £31,000, and for a total annual cost of £2,350, you will be able to light your streets at an extra cost of 15s. 2d. per lamp, providing a demand for 3,500 private lamps arises. That is to say, the extra cost of lighting your streets by electricity will be £550, and the result will be that instead of having 725 lamps which give at their best 20 c.p., you will have the equivalent of 850 lamps giving 32 c.p.—that is quite double the present illumination.

If it is assumed that there are 5,000 private lamps connected to the mains, then the expenses will be raised by £350, and the revenue will be increased by about £750. The balance is then reduced to £150. I feel confident that before many years the profit on the private lighting will be sufficient to enable you to light the streets for almost nothing. Every new lamp will bring you in a profit of from 3s. to 4s. per annum. Therefore, if you obtain in a few years' time a total of 15,000 private lamps, you will be able to light the streets for nothing. There is no reason why you should not reach this total soon. In Hampstead the station has not been started a year, and they already have nearly 10,000 lamps connected and applied for. Neighbouring districts could also obtain light from your station without great expense or any difficulty.

In the second scheme, which provides for the lighting of the main streets only, I have estimated for a plant to light 600 32-c.p. public lamps and 3,000 private lamps. I have estimated for the replacement of some 400 of the existing public lamps. The following will be the streets in which the proposed new lamps should be placed : Broadway, Merton-road, Hartfield-road, High-street, Ridgway, Copse-hill, Worple-road (part of), Southside, Parkside, Church-street, Arthur-road, and Wood-side, and small portions of adjacent roads. This scheme, briefly summarised, shows that with a capital expenditure of £20,000, and a total annual cost of £2,310, you will be able to light about 400 of your lamps at an extra cost of £1. 6s. 6d., including 325 oil lamps, provided a demand for 2,500 private lamps arises.

Even assuming that the private lighting is not taken up to the extent anticipated by me, I cannot see that it is possible for the annual cost of lighting by electricity to exceed the estimated cost of lighting by gas. With only 1,000 private lamps connected I do not think the annual cost of lighting the streets would exceed £3,000.

The lighting of streets by incandescent lamps is rapidly being improved. It has been tried in the City of London, but here, as well as in some other cases, the mixing of the brilliant white arc lamps and the yellow glow of the incandescent lamps has not been very successful. In England, street-lighting by incandescent lamps may be seen in successful operation at Chelmsford, Weybridge, Woking, Fareham, Whitehaven, and Portsmouth. In Ireland there are a few towns so lighted, while in Germany and America especially, many towns have incandescent lighting. At Chelmsford a local company charge the corporation £2. 5s. 6d. per 32-c.p. lamp. If a company can afford to do satisfactory lighting at that price, it should be within the province of a local authority to work at no greater outlay. At Kingston, though a loss has been made up to the present, the revenue for the quarter ending March, 1895, was more than double that of the previous March quarter, and the working expenses were no greater.

I have based all my figures on actual experience. I do not think that any will be exceeded. The working expenses will, however, depend greatly on the skill and ability with which the station is managed.

The system proposed is that known as the high-pressure alternating-current system. It is the only practical system that can be used for the Wimbledon district owing to the large and scattered area that has to be served. By means of high pressure one is able to transmit large power over great distances with very small cables. It is analogous to a high-pressure supply of water. A low-pressure system would entail an expenditure of £30,000 or £40,000 in copper mains alone. The high-pressure current will be transformed down at fixed points in the streets and also at large consumers' premises to a low pressure, which is distributed by means of other cables to the various public lamps and small consumers.—[A report of the proceedings of the Wimbledon Council in connection with this matter will be found among our "Business Notes."]

CUBA SUBMARINE TELEGRAPH COMPANY, LIMITED.

The forty-eighth ordinary meeting of this Company was held on Wednesday at the offices, 58, Old Broad-street, Mr. C. W. Parish occupying the chair.

The **Chairman** moved the adoption of the report, which recommended a dividend of 8 per cent. per annum. He said the traffic receipts for the half-year amounted to £29,164, or an increase of £5,976 ; but this increase was quite abnormal, and resulted entirely from the unfortunate revolution now going on in Cuba. Many of the land lines at the eastern end of the island had been destroyed by one party or the other, and, consequently, senders of messages had been glad to avail themselves of the Company's lines. The expenditure was £6,118, or an increase of £1,105, but part of this sum was due to income tax adjustment, leaving the actual working increase only £817. They had thought it advisable to add £1,500 to the reserve fund against loss on deposits in banks, for business had not revived so quickly as was expected in either South America or Australia, and the first duty of the directors was to be on the right side. A sum of £3,540 remained as balance to carry forward, and they were also able to place £13,638 to the reserve fund. They were especially glad to be able to strengthen their reserve in that way, for he was bound to prepare the shareholders for the fact that a reduction in tariff appeared to be very imminent. The directors had warned them of the change from time to time, and they had staved it off as long as possible. It was most necessary that their financial position should be as strong as possible. In conclusion, he said their cables were working well, and were in excellent order.

Mr. G. Keith seconded the motion, which was adopted.

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CONDUIT WIRING.

The report of Prof. W. E. Ayrton on the tenders for the electric lighting of the North-Western Fever Hospital, given elsewhere in this issue, will be read with a considerable amount of interest. In the first place, there will probably be no differences of opinion as to the advisability of a conduit system for new buildings, and where possible for old buildings. There may be cases, however, where such a system is impracticable. Another point will excite differences of opinion—namely, that referring to the use of metallic conduits. There is no doubt but that the use of metallic conduits does open up a source of trouble. Much of the wiring that is carried out in this country is bad—to use a simple expression—and this bad work is better than much which is carried out in other countries, especially—if our information is correct—in the States. Specifications for public buildings such as this upon which Prof. Ayrton reports are far more stringent in the use of good materials than small private customers. The latter are all for cheapness, except in the matter of talk, and generally get better work than they bargain for, while the former are not so pinched for funds nor so exacting as regards lowness of prices, and usually get worse work than is paid for. This, by the way, is not true only of electrical work, but of all their work. Assume, then, that the insulation is all that is required, the metal conduit may be all right and cause no particular danger; but, on the other hand, if the insulation at any point be not up to the mark, the metal conduit will, as we have previously said, prove a weak point in the lighting. Is there any particular necessity to trouble much about mechanical strength? Surely, in a properly-designed conduit system for internal wiring mechanical strength is of secondary, if not of tertiary, importance. What are really the primary requirements? In the first place, there ought to be absolute immunity from danger of fire. That stands far and away before all other requirements. Then we must have accessibility, ease of examination, ease for rewiring, for extension, no defacing of walls or ceilings, and no interference with decorations. There must be absolute continuity of conduits, and due provision for cut-outs, switches, and drainage. It seems, upon an examination of these requirements, that mechanical strength plays a somewhat unimportant part except at bends and junctions. Prof. Ayrton prefers zinc to earthenware for mechanical reasons. In our view, the latter is preferable for electrical reasons. The question of jointing bends to straight pieces presents no very great difficulty nowadays, nor need there be any particular fear of infringing patents. There is no difficulty of getting as good alignment with one class of tube as another. Of course, if the metal tube is glazed in the interior, it couples both mechanical strength and defence to short-circuits and fire. Again, we must guard against any words being taken as damaging to a conduit system, for we agree with other writers that "the use of conduits affords the only safe, reliable, and permanent method of wiring for electric lighting." With regard to this part of the subject, the plain moral is that metal conduits

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involve better insulation, and if this is not obtained tends to danger. The cost throughout is much greater, and the difficulty is to find the compensating advantages.

There is one other topic involved in this report which we mention only to emphatically condemn. Prof. Ayrton says: "I specified—*Samples of the conduit which the contractor proposes to use for protecting the conductors from abrasion, vermin, damp, etc., must be sent with the tender.*" With all due respect to Prof. Ayrton, this is not specification at all; it is merely an indication of "instability of knowledge," or of "instability of determination," or the following of a fashionable method of procedure. In the case of Prof. Ayrton, there is no lack of knowledge and no lack of determination; hence we must conclude that he merely follows a fashion—and this fashion, we say, is bad. It is not the place of contractors to say what they will do: it is the place of the consulting engineer to say what is to be done. The specification should have been clear. If the consulting engineer's opinion was in favour of a conduit system, he should have specified the material and size of the conduits, the material and size of the boxes, of the cut-outs, etc. There should have been no option given to the contractor. Failing this, it is impossible to say whether the prices of the tenders are good, bad, or indifferent. There is no earthly use in having a consulting engineer to specify general ideas—anybody can do that, even the much-maligned "electrical plumber." A consulting engineer should be master of his subject, his specification should be a specification, and not a loose statement that the contractor must comply with the fire insurance or the Board of Trade rules and regulations. Either the consulting engineer is capable of providing a scheme or he is not. If not, give up the attempt; if capable, specify it so that the tenders may be viewed from the same standpoint. Can you imagine a Great George-street engineer specifying a bridge by means of a few general ideas and asking contractors to provide tenders and designs on those lines? If Prof. Ayrton is in favour of zinc, iron, glass, or earthenware for the conduits, he should have specified his favourite material and let the contractors all tender for that material, and not have followed in the way of fashionable generalities. What was his estimated cost? and for what? Usually the engineer or architect gives an estimate as a guide to his employers. Why is not this plan followed by electrical consulting engineers?

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

CONCERNING FUMING SULPHURIC ACID.

SIR,—The so-called Nordhausen or fuming sulphuric acid ($H_2S_2O_7$) is a compound of a molecule of ordinary sulphuric acid (H_2SO_4) with a molecule of sulphuric anhydride or sulphur trioxide (SO_3); by heating the fuming acid the molecule of SO_3 is readily driven off.

Nearly every text-book on chemistry informs the student that this acid is still manufactured in Nordhausen, in Saxony, Germany. As a matter of fact it was never manufactured in the said town, but in Goslar, a couple of miles from Nordhausen. At the present time, however, this acid is not manufactured at all either in or near that place; but this particular chemical branch is, practically speaking, monopolised by the large chemical concern of Johann D. Starck und Söhne, near Prag, Böhmen, Austria. They produce it in the old-fashioned manner by distilling green vitriol or ferrous sulphate: $Fe_2(SO_4)_3 = Fe_2O_3 + 3SO_3$. The anhydride thus given off is absorbed by rain-water or sulphuric acid 66deg. Beaumé, thus producing fuming acid.

About 25 years ago, Prof. Cl. Winxler, of Freiburg, suggested the use of platinised asbestos as a "catalytic" substance for the union of pyrite—or brimstone—kiln gas (SO_2), sulphur dioxide, with the oxygen of air. The most favourable proportions are 29·6 vol. SO_2 + 70·4 vol. atmospheric air (containing 14·8 vol oxygen); but for practical purposes it is advisable to employ a dry gaseous mixture of 25 per cent. SO_2 + 75 per cent. air. The dry anhydride does not attack cast or tinned iron. In some works in Russia and Germany this process is actually carried out on a commercial scale with some modifications and improvements on the old idea.

In Kalk, near Köln (Cologne), in Germany, Wolter's process is used by distilling hydric sodic sulphate: $2NaHSO_4 = Na_2SO_4 + SO_3 + H_2O$. The sulphate of soda is then treated with sulphuric acid in order to get again hydric sulphate: $Na_2SO_4 + H_2SO_4 = 2NaHSO_4$.

About five years ago a German chemist produced the fuming acid from the ordinary sulphuric acid by means of an electric current. Carbon plates about $\frac{1}{8}$in. apart are immersed in sulphuric monohydrate, and an electric current passed through the fluid. The water of the acid is decomposed into hydrogen and oxygen, and the SO_3 is absorbed by the electrolyte, thus forming fuming acid: $SO_3 + H_2SO_4 = H_2S_2O_7$. As soon as a layer of sulphur is observed on the electrodes the current is reversed. As far as the writer knows, this electrical process has never been tried on a commercial scale.—Yours, etc., R. W. HILL.

MULTIPHASED ALTERNATE-CURRENT SYSTEMS.

SIR,—With reference to your interesting leader this week, I have long thought that sufficient attention has not been paid to the lighting of many small towns in the mountainous parts of this country. At the same time there are serious difficulties in the way. In most of the smaller towns there is not sufficient money to establish a local company or district council works, whilst the return would be hardly sufficient to induce outsiders to invest in such work.

Beyond this, there are the Board of Trade regulations to consider, and unless the Board relaxes the regulations as to constant supply at a given pressure and as to overhead lines, it would in many cases that I have in my mind be almost impossible for a company to make a living. In most cases overhead wires would be imperative except in the centre of the town.

Further than this, it must not be forgotten that a mountain torrent usually varies enormously in volume, so that unless considerable expense is incurred for storage the minimum is not sufficient for the load, in which case coal has to be carted. Added to this is the fact that most of the suitable water rights are already occupied, and that in very few towns is there water power available in the town itself, but more often some distance off.

In most such towns, also, the hydraulic machinery is unsuitable for the use of electric lighting, either being wasteful of water or taking up too much space. At the same time, I think more use might often be made of water power than at present is the case.—Yours, etc.,

Littlehampton, August 2, 1895. GEO. T. PARDOE.

NORTH-WESTERN FEVER HOSPITAL.

The following report on the tenders for electric lighting has been submitted to the Metropolitan Asylums Board by Prof. W. E. Ayrton:

"Until comparatively recently the recognised method of running electric wires in buildings was to place them in wooden casing, the capping of which had to be removed both to put in the wires and to inspect them. Although this system

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found favour with the fire insurance companies, gradually people realised that it possessed many serious defects, and so conduit systems began to be developed. With these, pipes made of either bitumenised paper, earthenware, iron, steel, or zinc are embedded in the walls during the construction of the building, and subsequently the going and return conductors are drawn into these pipes or drawn out again without disturbing the walls should the conductors at any time become defective. When, therefore, it was decided to electrically light the new isolation block and pavilions, I applied to the Westminster Insurance Office for permission to use such a conduit system. Their surveyor of risks admitted the force of my arguments in favour of a conduit; but, as he had to obtain the consent of several insurance companies, who share the North-Western Hospital fire risk, it was not until I had had several interviews that he gave his consent, which was coupled, however, with a statement of his preference for a *non*-metallic tube. Under these circumstances, and especially as the details of several of the conduit systems are covered by patents, and therefore can only be used with the permission of the holder of the patent, I considered it undesirable to specify the material of the conduit with the minuteness with which I had described the other details in the specification for the wiring of the isolation block and pavilions. And further, to enable any firm to tender that was prepared to employ a conduit system, as distinguished from the old-fashioned wooden casing, I specified: '*Samples of the conduit which the contractor proposes to use for protecting the conductors from abrasion, vermin, damp, etc., must be sent with the tender.*' Appended is a list of the tenders, arranged in increasing order of price, and attached to each is a description of the material proposed to be used for the pipe:

Name of firm.	Amount of tender.	Material of Conduit.					
		Bitumenised paper.		Earthenware.	Iron.	Steel.	Zinc.
		Plain.	Covered with brass where mechanical risk.				
	£ s. d.						
Thorpe and Waring	554 0 0	Plain	—	—	—	—	—
Electrical and General Engineering Company	649 0 0	—	Covered with brass where risk of mechanical injury.	—	—	—	—
Thos. Matthews	650 0 0	Plain	—	—	—	—	—
Waring and Sons, Limited..	688 15 0	—	—	Thick	—	—	—
Fowler, Lancaster, and Co..	895 15 0	—	—	—	—	Bored steel tubes where risk of mechanical injury.	Rolled sheet zinc bent into tube & soldered
Benham and Sons	870 0 0	—	—	White	—	—	—
Paterson and Cooper	895 0 0	Plain	—	—	—	—	—
Julius Sax and Co., Limited	944 8 9	—	—	Doulton's	—	—	—
J. C. Howell, Limited	981 16 4	Plain	—	—	—	—	—
London and Lancashire Electric and General Engineering Co., Ltd. ...	1,050 0 0	—	—	—	Complete iron system; iron sockets for switches, etc.	—	—
Miller and Woods	1,070 0 0	—	—	—	Iron.	—	—
Sharp and Kent	1,098 0 0	—	—	—	Ordinary gas barrel	—	—
Tayler Smith Electrical Company, Limited.....	1,124 0 0	Plain	—	—	—	—	—
Roger Dawson, Limited ...	1,140 0 0	—	Covered with brass where risk of mechanical injury.	—	—	—	—
Hayward Tyler and Co. ...	1,340 0 0	—	—	—	Complete iron system; iron sockets for switches, etc.; pipes coated with Angus Smith's compound	—	—
V. C. Middleton	1,440 0 0	—	—	—	Iron	—	—
Vaughan and Brown, Ltd. .	1,557 0 0	—	—	—	Ordinary gas barrel	—	—

"After a careful survey of the 17 tenders, and of the samples accompanying them, I am of opinion, for the following reasons, that the Board will receive the best value for their money by accepting the tender of Messrs. Fowler, Lancaster, and Co. for £859. 15s.:

"(i.) Zinc tubes, such as those proposed by Messrs. Fowler, Lancaster, and Co., are much stronger than those made of bitumenised paper, and will stand the action of damp and of cements better than paper.

"(ii.) Zinc is stronger than earthenware unless the latter be very thick; further, zinc tubes can be obtained in greater lengths, and also can be joined together more easily, than earthenware tubes. Therefore, zinc is to be preferred to earthenware for mechanical reasons, and, when insulated wire of the class stated in the specification is employed, no electrical advantage is practically gained by using a tube composed of non-conducting material.

"(iii.) As Messrs. Fowler-Lancaster are prepared to use steel tube where, in my opinion, there is a special risk of mechanical injury, their system is nearly as good as one in which iron pipes are used throughout.

"(iv.) The tender of Messrs. Fowler-Lancaster is nearly £200 less than the lowest of those in which iron pipes are quoted for, and only £300 more than the lowest tender of all. And as this latter is for a simple paper-tube system, I do not recommend its adoption.

"(v.) As Messrs. Fowler-Lancaster's zinc tubes are made out of *rolled sheet*, and as the steel tubes they use are *smooth inside*, there is far less risk of damage to the insulation of the conductors in drawing in than if rough gas barrel were employed, as is contemplated in some of the higher tenders.

"(vi.) Lastly, Messrs. Fowler-Lancaster have good testimonials for the success they have obtained in the use of their zinc tubes.

"I therefore recommend that the tender of Messrs. Fowler, Lancaster, and Co., for £859. 15s., be accepted. Finally, I would suggest that the Board having received a tender which is only fifth from the lowest, for a combination system of special zinc tube and smooth steel pipe, furnishes a conclusive proof of the advantage that the Board has derived from the material of the conduit having been left open in the specification."

[And Messrs. Fowler, Lancaster, and Co.'s tender has been accepted according to the report—the statement in our issue of July 26 that the lowest tender was accepted, being, we regret to say, inadvertently and unfortunately incorrect.—Ed. *E. E.*]

LIVERPOOL CORPORATION AND ELECTRIC LIGHTING.

DETAILS OF THE SCHEME OF PURCHASE.

We herewith give the full text of the report which the chairman of the Lighting Committee of the City Council (Alderman Frederick Smith) has prepared with regard to the purchase of the business of the Liverpool Electric Supply Company, Limited:

It will be within the recollection of the Council that, by the Liverpool Electric Lighting Order, 1892, the Corporation obtained power to purchase, as a going concern, the portion of the undertaking of the Liverpool Electric Supply Company, Limited, within the city of Liverpool, on giving not less than 12 months' notice prior to June 30, 1898, or on any subsequent June 30. The earliest date for purchase fixed by the order of 1892—namely, in the year 1898—was, by arrangement made with the company during the enquiry on the question of the extension of the city boundaries, extended to the year 1900, on condition

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that the company gave the Corporation power to buy that portion of their undertaking in Toxteth Park, as well as the portion in the existing city. Soon after the committee were appointed in November, 1894, they approached the directors of the company with the view of ascertaining whether the directors would be willing to negotiate for the purchase of the undertaking by the Corporation in the year 1895, instead of waiting until the year 1900, and the directors intimated that they were prepared to negotiate, provided the committee had authority from the Council to complete the bargain, if the terms could be mutually agreed upon. The committee consequently recommended the Council to give them that authority, and on January 9, 1895, the Council passed the following resolution: "That the Council offer to purchase from the Liverpool Electric Supply Company, Limited, the whole undertaking and business of the company, as a going concern, during the year 1895 (instead of waiting until the period arrives when the Corporation can compel the company to sell their undertaking, as a going concern), at such price and on such other terms and conditions as may be agreed upon between the company and the Special Lighting Committee, or, failing such agreement, as may be settled by arbitration in manner provided by the Liverpool Electric Lighting Order, 1892, and that the Special Lighting Committee be authorised to take all steps, and to do whatever may be necessary, to carry out the object of this resolution, and that the Lord Mayor be respectfully requested to affix the corporate seal to any document that may be necessary." In accordance with that resolution, the committee entered into negotiations with the directors of the company, and arranged, provisionally, the terms of purchase, subject to the undertaking being examined by an expert and to his report being a favourable one. The committee thereupon called in Sir Frederick Bramwell to examine the whole of the machinery and works of the company, and to report. In a lengthy report describing the character of the works, Sir Frederick Bramwell concluded with the following remarks: "As a summary, and in conclusion, I am of opinion that the Corporation, in acquiring the undertaking of the Liverpool Electric Supply Company, will become possessed of a means of generating and distributing electrical energy which has been well designed, has been well carried out, has been maintained in admirable condition, and has worked, and will continue to work, with an economy that, so far as I know, has never been surpassed."

After this report was received, the committee agreed that the Corporation should purchase the undertaking on the terms set out in the following agreement:

"An agreement, made the 28th day of May, 1895, between the Liverpool Electric Supply Company, Limited (hereinafter called 'the company'), of the one part, and the Mayor, Aldermen, and Citizens of the city of Liverpool (hereinafter called 'the Corporation') of the other part. (1) The company agree to sell, and the Corporation agree to purchase, for the sum of £400,000, the whole of the undertaking and other works of the company, and all their property and assets, real and personal (except as hereinafter mentioned), with all their rights, powers, and privileges, subject to all enactments, contracts, obligations, rights, and liabilities affecting the same at the date of completion of the purchase, but subject to the provisions hereinafter contained and excepting out of the said purchase: (*a*) The reserve and renewal fund of the company, amounting to £18,000, which shall continue the property of the company, to be dealt with as hereinafter mentioned. (*b*) All the minute-books, share registers, transfer-books, books of account, letter-books, and documents of the company, which shall remain the property of the company until its dissolution, after which the same (except the minute-books) shall be handed over to the Corporation, but after completion of the purchase the Corporation and their officials shall have access to the said books and documents whenever required by the Corporation. (2) The purchase shall be completed and the purchase-money paid on the 2nd day of September, 1895, or on such other date not later than the 1st January, 1896, as may be agreed upon between the company and the Corporation, or, failing agreement, as shall be settled by the Board of Trade, and if from any cause the purchase shall not have been completed by the 1st day of January, 1896, then this agreement shall be at an end, unless the Corporation and the company agree that the purchase shall be carried out at some later date. (3) The Corporation shall be liable to, and shall pay and discharge, all the debts and liabilities of every kind of the company existing on the date of completion of the purchase, including liabilities in respect of causes of action then existing and arising in connection with the carrying on of their undertaking in the usual course of business, and shall effectually indemnify the company and its directors therefrom. And the Corporation shall be entitled to all debts and sums of money then owing to the company, and the company shall, until their dissolution, allow the Corporation in the name of the company to take all such steps and proceedings at the expense of the Corporation as the Corporation may require to recover any debt or sum of money to which the company may be entitled on the date of completion of the purchase. (4) Until the actual completion of the purchase the company shall retain their present control and management of their undertaking, and shall carry on and manage the same in the ordinary and regular course of business, and from and after the date of this agreement shall carry on the same for the benefit and at the risk of the Corporation, subject as hereinafter provided, and shall also continue to keep proper accounts and may expend on capital account such sums as they think necessary for the reasonable extension of their business in order to enable them to carry out their statutory obligations or otherwise in the proper conduct of the business of the company, and may from time to time borrow such sums as may be necessary for the purposes aforesaid, but shall not after the date hereof make any other expenditure on capital account except at the request of the Corporation, provided that the provisions of this paragraph shall operate only as between the company and the Corporation, and shall not in any manner affect any other person even with notice thereof. (5) The company shall be entitled out of the receipts of the undertaking to declare and pay a dividend or dividends to their shareholders in respect to the present share capital of the company at the rate of £6 per centum per annum, free of income tax, from January 1, 1895, to the actual completion of the purchase, every such payment being made at such time and in respect of such period as the directors of the company may from time to time determine. (6) The engineer of the company (Mr. A. Bromley Holmes) and every other officer and servant of the company (but not including the directors and solicitors) who on the date of completion shall be in the employment of the company, shall (unless he signifies in writing to the Corporation that he does not desire to enter their service) be taken over by the Corporation on the same terms as to position and emoluments as those under which he was employed by the company on the 1st of January, 1895. The said engineer shall, when in the service of the Corporation, be entitled to continue to take pupils, and shall also be entitled to continue, for his own benefit, his general practice as an engineer, but not so as to prevent the efficient discharge of his duties as engineer to the undertaking hereby agreed to be sold to the Corporation. No officer or servant of the company taken over by the Corporation under this article, and signifying to the Corporation in writing within six months from such taking over that he does not desire to contribute to the superannuation fund of the Corporation, shall be under any obligation to contribute thereto, or entitled to participate therein. (7) The cost and expenses of the company in respect of the transfer of their undertaking, works, and property to the Corporation, and the winding up of the company, including the costs and expenses of this agreement and of all negotiations in connection therewith and all their costs and expenses of and incidental to the provisional order which the company have already applied for this session, and all their costs and expenses of and incidental to obtaining the ratification by Parliament of the terms of this agreement, shall be paid by the company out of their said reserve and renewal fund, and the Corporation shall not be liable to pay the same. The residue of the said fund, after payment of the cost and expenses aforesaid, shall be applied in manner following—that is to say: First, in payment of such sum or sums as the directors think fit to any officers and servants of the company (other than the directors) whose services the directors shall be of opinion have been such as to call for recognition. Secondly, in payment of the costs of winding up the company. Thirdly, in payment to the directors of the company in acknowledgment of their services of such sum as the shareholders in general meeting may determine, and the balance (if any) shall form part of the assets of the company distributable among the shareholders. 8. The company will in the present session of Parliament endeavour to obtain the confirmation by Parliament, either in the said provisional order or in the Bill confirming the same, of this agreement, or of clauses comprising or carrying into effect the provisions of this agreement, and the Corporation will assist in obtaining such confirmation of the terms of this agreement by Parliament. (9) This agreement is made subject to the approval of Parliament during the present session, and to such alteration as either House of Parliament may think fit to make therein; but in the event of either House of Parliament making any material alteration therein it shall be in the option of either party to withdraw from the same, and the question whether any alteration made herein is material or not shall, if disputed, be decided by arbitration in the manner hereinafter provided. (10) This agreement is also conditional on the same being duly approved by the shareholders of the company, and is subject to a provisional order for extending the boundaries of the city of Liverpool so as to include the district of Toxteth Park being confirmed by Parliament during the present session. (11) If any dispute shall arise between the parties hereto with reference to the true construction of this agreement, or with reference to anything to be done thereunder or otherwise under or in relation thereto, such dispute shall be referred to an arbitrator, to be agreed on between the parties, or, failing agreement, to two persons (one to be appointed by

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each party to the reference) or their umpire. And this shall be deemed to be a submission to arbitration within the Arbitration Act, 1889, or any statutory modification or re-enactment thereof for the time being in force, the provisions whereof shall apply so far as is applicable. In witness whereof the company and the Corporation have hereunto affixed their respective seals the day and year first before written.

It will be seen that the purchase is to include, not only the company's undertaking in the city, but that within Toxteth Park also. In order to carry out the agreement for the purchase, it is necessary that parliamentary sanction be obtained. The committee thought it possible that the terms of the agreement might have been included in a Bill to confirm the provisional order which the company are promoting during the present session, but the authorities of the House of Lords, after a good deal of consideration, decided that as a matter of procedure it would be necessary for the company to promote a separate Bill to carry out the agreement, and to authorise the Corporation to borrow the necessary capital to pay for the undertaking. The committee have arranged with the company to take this course, and it has been agreed that one-half of the taxed costs of the Bill shall be paid by the directors out of the reserve fund, and the other half out of the ordinary assets of the company. The purchase will be dependent on the extension of the city boundaries being carried out.

The total sum required to be borrowed by the Corporation will have to be repaid within a period to be fixed by the Local Government Board after the Act to authorise the purchase has been obtained. In the case of the London County Council the Treasury have within the last 12 months adopted a period of 42 years for electric lighting purposes, and there is no reason why the Local Government Board should not adopt the same period. Calculating interest at 2¾ per cent. (to be on the safe side), and assuming a period of 42 years is allowed for repayment, and calculating the total capital required by the date when the purchase will be completed at £425,000, the annual charge to the Corporation for interest and sinking fund will be £17,187. If a period of 35 years is taken, the annual charge would be £19,064. As against this annual charge, the Corporation will have an undertaking which for the year 1894 produced a net revenue of £20,908 after payment of working expenses, maintenance, and directors' fees and legal charges. The directors' fees and solicitors' charges amounted in 1894 to between £900 and £1,000, and as these charges will not be payable if the Corporation purchase the undertaking, the net revenue for the year, from a Corporation point of view, may be taken at £21,800. During the first six months of the present year there has been a considerable increase in the business of the company, the gross receipts from the sale of electricity showing an increase of £2,500 on the receipts for the corresponding period of last year.

The following table shows the development of the undertaking during the last five years :

Year.	Number of lamps on December 31.	Sales of electricity.	Profit before deducting depreciation.
1890	11,752	£13.343	£7,792
1891	14,966	20,123	11,760
1892	20 254	25,515	16,751
1893	25,784	27,258	17,507
1894	31,792	31,352	20,908

During the first six months of 1895 the number of lamps has increased from 31,792 to 33,800. It is, therefore, reasonable to calculate that the net income from the undertaking for 1895 will be between £23,000 and £24,000, as against an annual expenditure by the Corporation of £17,187 if 42 years for repayment of the borrowed money is allowed, and as against £19,064 if 35 years is allowed. When the Corporation acquire the undertaking they will be able to increase the gross receipts in a short time by between £3,000 and £4,000 per annum by lighting the public buildings in the centre of the city with electricity instead of gas. This can be done almost entirely from the existing mains of the company, and only a small capital expenditure will be necessary to carry it out. The amount paid to the gas company in 1894 for gas supplied to all the public buildings was £7,065. 2s. 10d., and the amount paid in respect of those buildings in the centre of the city which could easily be lighted by electricity was £3,486. 16s. 7d. In addition to this, the Corporation will be in the position to consider the question of lighting the chief streets with electric light instead of gas, and of supplying electricity for motive power. The share capital of the company consists of 50,000 £5 shares, and the company had spent additional capital on the works to the extent of about £16,000 up to May 31, 1895. Since July 1, 1894, the company have paid a 6 per cent. dividend, and by their provisional order of 1891 they can pay a dividend up to 7 per cent., but after that point has been reached one-half of the surplus profit must be applied in the reduction of charges, and the other half can be paid as additional dividend. By the purchase of the undertaking the Corporation will get the right of supplying the city with electricity into their own hands at a price which is undoubtedly a good one for the company, but at the same time one which should give the Corporation, after paying interest and sinking fund, maintenance and working expenses, a considerable margin on revenue account, and there is every probability that the Corporation will be able to make substantial reductions on the present charges made by the company for electric light. In anticipation of the purchase being carried out, the committee have recommended the Council to apply next year for a provisional order to include the whole of the city, as then existing, within the area of supply.

MANCHESTER CORPORATION ELECTRIC LIGHT STATION.

The following is the report of the electric light department to the City Council for the year ended March 31, 1895 :

Your committee have pleasure in submitting to the City Council the abstract of accounts for the year ended March 31, 1895, prepared in the form prescribed by the Board of Trade, and also in reporting the following particulars as to the year's working : The number of consumers at the close of the year was 741, being an increase of 329 as compared with the previous year. The number of lamps in use was : incandescent 30,316 (of 16 c.p.), arc 385, as compared with 18,478 and 250 respectively. There were also 17 motors in use, representing 16 h.p., as compared with 11 motors, representing 16-h.p., last year. The total length of mains laid was 63 miles 258 yards. The total quantity of current accounted for was 1,199,988 units.

Revenue Account (*Abstracts* 3 *and* 4).

			£ s. d.
The amount received for sales of current, which works out to 5·63d. per unit accounted for, was...			28,145 3 6
The rental of meters was			494 19 11
Making a total revenue of			£28,640 3 5
The cost of generation, distribution, and management was	£10,991 17 4		
To which must be added—For interest, bankers' commission, and sinking fund	7,938 18 7		
For transfer to renewals account	4,000 0 0		
		22,930 15 11	
Leaving a balance of			5,709 7 6

which has been dealt with as follows :

	£ s. d.
To previous year's debit balance	209 18 10
Carried forward to next year's account (of this sum it has been decided to pay £5,140. 12s. 11d. to the city fund in aid of rates for the year ending March, 1896, as per estimates)	5,499 8 8
	£5,709 7 6

The reduction in the price of current from 8d. to 6d. per unit is estimated to affect the revenue during the current year to the amount of £4,650, but it is expected that increased business will to some extent recoup the committee for this reduction. The works reported last year to be in progress, with the new offices, workshops, and storerooms, have been completed, and are now in full use and occupancy. The following statements are appended—viz., No. 1, statement as to loans (these amount to £150,000) ; No. 2, capital account (this shows a total expenditure of £174,810, the total receipts being £150,000) ; No. 3, revenue account ; No. 4, net revenue account ; No. 5, sinking fund account (there is £4,924 carried to next year's account) ; No. 6, renewals account (£4,000) ; No. 7, general balance-sheet ; No. 8, statement of electricity generated, sold, etc. The two new 400-i.h.p. engines, with the dynamo machines and Lancashire boiler, referred to in last year's report, have been put to work. The switchboard has been extended to suit. The entire plant has worked satisfactorily, and there has been no interruption in the supply of current of more than a minute or so, and then only on a portion of the system, throughout the year. The applications for the supply of electricity have been so numerous that, as already reported to the City Council, your committee have decided to increase the plant at the central station, Dickinson-street, by the following—viz., five Lancashire boilers, 30ft. by 8ft. ; eight dynamos, each of 240-unit capacity ; six pairs of vertical compound condensing engines of 400 i.h.p. each ; two pairs of horizontal compound condensing engines of 400 i.h p each. It has also been decided to erect a storage battery at the Hunt's Bank sub-station of sufficient capacity to supply 4,000 16-c.p. incandescent lamps. It has also been arranged to extend the supply of electricity in and along the following streets—viz. : Oxford-street, Stretford-road, London-road and Downing-street, Port-street, Rusholme-road, Sackville-street, Chorlton-street, and Minshull-street, Swan-street (Oldham street to Shudehill), Whitworth-street, Shudehill, Withy-grove, and Fennel-street, Hunt's Bank. The Local Government Board have given power and authority to the Corporation to borrow the sum of £100,000 for carrying out the foregoing extensions and increase of plant, which are expected to be partly available for the ensuing winter of 1895-6. The plans for these extensions are in a forward state, and main-laying has already been begun. The method of distribution will be as before—on the five-wire system ; and it is intended to carry out the extensions of mains by the Corporation's own staff.

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REVENUE ACCOUNT, YEAR ENDING MARCH 31, 1895.

Dr.	£ s. d.	£ s. d.
To Generation of Electricity.		
Coal (including cost of unloading, etc.)	2,446 3 7	
Oil, waste, water, and engine-room stores	1,128 19 6	
Wages at generating station	2,300 6 2	
Repairs and maintenance, as follows: buildings, £7. 2s. 4d.; engines, boilers, dynamos, switchboards, cranes, instruments, tools, etc., £697. 8s. 6d.; sundries (including wages), £215. 12s. 4d.	920 3 2	
Current used on works for lighting and motive purposes, £381 6s. 10d.; repairs and maintenance of lamps, etc., £63. 0s. 7d.	444 7 5	
		7,239 19 10
To Distribution of Electricity.		
Wages	353 16 10	
Repairs and maintenance, as follows: mains, £13. 11s. 8d.; meters, £14. 4s. 2d.; sundries (including wages), £21. 4s. 4d.	49 0 2	
		402 17 0
To Rents, Rates, and Taxes.		
Chief rents	124 6 5	
Rates and taxes	729 3 4	
Rents of sub-stations, etc.	75 17 10	
		929 7 7
To Management Expenses.		
Salaries—viz., engineer's department	1,196 5 10	
Clerical staff	622 7 8	
Stationery, printing, and advertising	306 8 8	
General establishment charges	154 15 7	
		2,279 17 9
To Law and Parliamentary Charges and Expenses.		
Law expenses	6 12 10	
Stamp duty	28 17 9	
		35 10 7
To Special Charges.		
Insurances	9 6 0	
Official clothing	18 14 6	
Repairs and maintenance of office furniture	44 10 9	
Contribution to Manchester Corporation Thrift Fund	26 14 2	
		99 5 5
To bad debts—amount written off		4 19 2
		10,991 17 4
To balance carried to net revenue account		17,648 6 1
		£28,640 3 5

Cr.	£ s. d.
Sales of current	28,145 3 6
Rental of meters	494 19 11
	£28,640 3 5

NET REVENUE ACCOUNT, YEAR ENDING MARCH 31, 1895.

Dr.	£ s. d.	£ s. d.
Interest on mortgage debt	4,048 18 9	
,, ,, deposits held as security for current supplied	8 17 10	
,, ,, bank overdraft (less £23. 7s. 2d. transferred from sinking fund account)	220 15 9	
		4,278 11 4
Bank commission		38 17 0
Commission on loans		74 2 0
Sinking fund account—amount transferred		3,547 8 3
Renewals account—amount transferred		4,000 0 0
		£11,938 18 7
Balance carried down		5,709 7 6
		£17,648 6 1
Amount brought from last year's account		209 18 10
Balance being net profit at March 31, 1895, carried to next year's account (of this sum £5,140. 12s. 11d. will be paid to the city fund in aid of rates for year ending March 31, 1896, as per estimates)		5,499 8 8
		£5,709 7 6

Cr.	£ s. d.
Balance brought from revenue account	17,648 6 1
	£17,648 6 1
Balance brought down	5,709 7 6
	£5,709 7 6

GENERAL BALANCE-SHEET, MARCH 31, 1895.

Liabilities.	£ s. d.	£ s. d.
Capital account—amount received		150,000 0 0
Sundry creditors:		
Deposits held as security for current supplied	406 6 6	
Interest accrued on ditto	6 5 8	
Trade accounts owing	3,236 4 5	
		3,648 16 7
Amount owing to bankers	23,466 18 11	
Less in hand on sinking fund account	4,924 5 10	
		18,542 13 1
Amount owing to city treasurer for wages, etc., advanced		295 2 5
		172,486 12 1
Renewal account—amount at credit thereof		4,000 0 0
Sinking fund account—amount at credit thereof		4,924 5 10
Net revenue account—amount at credit thereof		5,499 8 8
		£186,910 6 7

Assets	£ s. d.	£ s. d.
Capital account—amount expended for works		174,810 16 1
Stocks on hand		1,465 15 5
Sundry debtors—accounts due for current supplied	£10,573 12 1	
Other accounts due	16 11 5	
		10,590 3 6
Cash in hand		43 11 7
		£186,910 6 7

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units	1 277,507
,, sold to private consumers by meter	1,168,382
,, used on works	31,606
Total quantity accounted for	1 199,988
Quantity not accounted for	77,519
Total maximum supply demanded in watts equivalent to 18,550 lamps of 16 c.p.	1,187,000

LEGAL INTELLIGENCE.

THE BOARD OF WORKS FOR THE WANDSWORTH DISTRICT v. THE COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY, LIMITED.

This case came before Mr. Justice Stirling in the Chancery Division of the High Court of Justice on Saturday last. It was a motion by the plaintiffs asking that the defendants, their servants and agents, might be restrained by injunction from excavating, or constructing, or placing in or under any highway within the plaintiffs' district any transforming or converting stations or other chambers or receptacles for the purpose of containing transformers or other apparatus for the purpose of transforming or converting electrical energy at a high pressure to energy at a low pressure, and from constructing or placing in or under any such highway any other chambers or stations not being street boxes authorised by Clause 12 of the provisional order granted by the Board of Trade in respect of Wandsworth, and scheduled to the Electric Lighting Orders Confirmation (No. 5) Act, 1892, and from using any boxes constructed by the defendants under the powers of the said Act for the purpose of transforming electrical energy as aforesaid, or for any other purpose not authorised by the said Clause 12. The question raised in the action was of considerable importance to public authorities and electric lighting companies—viz, whether, under the terms of the provisional order which authorised the placing of "boxes" under the streets for certain purposes therein specified, the defendant company were at liberty to construct chambers of considerable size under the streets of the plaintiffs' district for the purpose of containing apparatus to be used in converting or transforming electrical energy from high pressure to low. Section 9 of the provisional order referred to provided that the undertakers might supply energy within their area by means of some system to be approved by the Board of Trade, and subject to such regulations for securing the safety of the public as the Board of Trade might impose. Section 11 gave the undertakers certain powers to break up streets, etc, for the purpose of executing their works. Section 12 provided as follows: "Subject to the provisions of this order and the principal Act, and any regulations made under this order, the undertakers may construct in any street such boxes as may be necessary for purposes in connection with the supply of energy, including apparatus for the proper ventilation of such boxes, provided that no such box or apparatus shall be placed above ground except with the consent of the local authority, or person by whom such street is repairable. Every such box shall be for the exclusive use of the undertakers and under their sole control, except so far as the Board of Trade may otherwise order, and shall be used by the undertakers only for the purpose of leading off service lines and other distributing conductors, or for examining, testing, regulating, measuring, directing, or controlling the supply of energy, or for examining or testing the condition of the

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mains or other portions of the works, or for other like purposes connected with the undertaking; and the undertakers may place therein meters, switches, and any other suitable and proper apparatus for any of the above purposes."

The plans of the defendant company had been sanctioned by the Board of Trade, and included the construction of cast-iron receptacles to be placed under the streets The dimensions of the receptacles so authorised were 10ft. in depth, 7ft. 6in. in length, and 5ft. 6in. in width. and they were intended to contain instruments called transformers or converters. A transformer is an apparatus through which the electric current is passed with the view of changing or controlling its voltage. It consists of a mass of iron, round which are wound the primary and secondary conductors without being brought into contact, and according to the number of times the respective conductors are wound round the iron so is the pressure of the electrical energy diminished. In this way the current is rendered capable of being taken off the electric main and conducted at a safe pressure into the consumers' houses. The case of the plaintiff Board of Works was that the receptacles or chambers proposed to be used by the company were not street "boxes" within the meaning of the Electric Lighting Acts and the provisional order, and that, even if they were, the use of them for the purpose of transforming was not within the uses prescribed for such boxes by the order. They contended that it would be extremely inconvenient for public purposes if these large spaces were permitted to be taken up under the streets, and that, having regard to the safety of the public, it was not desirable that what was proposed should be done. "Transforming" was a well-known operation applied to electricity, and if it had been intended that the process of transforming should be allowed in these boxes, the word would have been expressly inserted in the order. The defendants, on the other hand, contended that the Legislature had used terms of the widest possible signification, and that their proposed operations were entirely within their powers.

Mr. Justice Stirling, in giving judgment, said that the question was really one of construction of the order which was granted by the Board of Trade and confirmed by Parliament, and which had all the efficacy of an Act of Parliament. After referring to the scheme of the order, his Lordship said that it was obvious that great powers were vested in the Board of Trade. First of all, the system of electric lighting was to be that which had met with the approval of the Board of Trade, and it was only to be used subject to such regulations as might be imposed by that body; and, secondly, where the operations of the undertakers involved the placing of works under, along, or across any street, the undertakers were to furnish details of what was proposed to be done to three bodies—viz, the Postmaster General, the local authority, and the County Council—and it was left to those bodies to approve or disapprove the plans; in the event of their being disapproved the undertakers might appeal to the Board of Trade, who had the function of adjudicating between the undertakers on the one hand and the three public bodies on the other. All that had been done in the present case. The Board of Trade had fixed upon the system to be adopted. They had defined it in the following manner: "A high-pressure alternating-current supply at constant pressure to transformers, which will be placed either in converting stations or, when the houses or buildings to be supplied are widely separated, on the consumer's premises. From the converting stations a low-pressure supply at constant pressure will be given to consumers by means of distributing mains The converting stations will be street boxes of sufficient size and suitable construction to contain several transformers, room being also provided to enable a man to enter the box and conveniently examine the transformers and controlling apparatus." According to the plans of the defendant company, the street boxes which were intended to be used, and which had been sanctioned by the Board of Trade, were receptacles made of iron, of which the dimensions were 10ft. in depth, 7ft. 6in. in length, and 5ft. 6in in width, and they were to be used for the purpose of containing the transformers which were to change the electricity from high to low pressure. The objection raised by the Wandsworth Board of Works was that the Board of Trade, in sanctioning these receptacles, had authorised something which, according to the terms of the order, the defendants were not entitled to use. That turned upon the construction of Clause 12. The notice of motion raised two points—first, that the receptacles were not "boxes" under the section; and, secondly, that the use of them for the purpose of containing the transformers was not properly sanctioned. His Lordship dealt with these questions separately. First, were the receptacles "boxes" within the Act? The "boxes" in common use at the time of the passing of the order were of much smaller dimensions than those now proposed to be used. But there was nothing in the Act as to size; and it seemed to his Lordship that the question of size was entirely within the province of the Board of Trade. Then it was said that the receptacles were really chambers and were so designated in the first plans put forward by the company; but the question was whether they might be described as "boxes." His Lordship thought that they might fairly be so described, and the Board of Trade had not gone beyond their powers in sanctioning them. Secondly, might they be used for the purpose of containing the transformers? The uses to be made of "boxes" were defined in the latter part of Clause 12—viz. (*inter alia*), for "regulating, measuring, directing, or controlling the supply of energy." It was not disputed that if the boxes might be used for transformers, the instruments themselves were such as might be properly used. But it was said that none of the words in the order described the function to which the transformers were appropriated. On the other hand, it was said by the company that the transformers were apparatus for regulating or controlling the energy. Their effect was to diminish the pressure in a certain fixed ratio depending upon certain conditions; and his Lordship came to the conclusion that the operation clearly came within the words "regulating and controlling," and the Board of Trade had not gone beyond their powers in sanctioning the use of these instruments in the "boxes." The motion was accordingly refused, and, by consent, the hearing was treated as the trial of the action, and the action was dismissed, with costs.—*The Times.*

WILSON v. THE ELECTRICAL COMPANY, LIMITED.

In this case, which was heard in the Court of Queen's Bench on Tuesday, defendants applied that the plaintiff's action be dismissed for want of prosecution, the plaintiff not having filed answers to interrogatories delivered pursuant to order made herein on July 6, 1895, without prejudice to the right of the defendants, the Electrical Company, Limited, to proceed with their counterclaim. The plaintiff, Mr. G. S. Wilson, now stated to be of the Zürich Incandescence Lamp Company, formerly in the employ of the defendants as traveller, applied for an extension of time in which to answer the above-named interrogatories. The plaintiff brings an action for damages against the defendants in connection with an alleged illegal acting upon an alleged invalid bill of sale.

The plaintiff was granted 10 days within which to answer the interrogatories.

COMPANIES' MEETINGS AND REPORTS.

WATERLOO AND CITY RAILWAY COMPANY.

The third half-yearly meeting of the above Company was held at Waterloo Station yesterday (Thursday) afternoon, Mr. Wyndham S. Portal in the chair.

The **Chairman** moved the adoption of the report of the directors and statement of accounts, which showed that the expenditure for the half-year ended June 30 amounted to £48,982. The probable further outlay within the current half-year rendered it necessary to make a call of £2 per share upon the 54,000 shares of the Company. The total capital created is £540,000. The general balance-sheet shows on the debit side, balance at credit of capital account, £80,085. 4s. 9d; interest accrued and provided for, £1,565. 10s. 1d.; and sundry outstanding accounts. £224. 12s. 5d.; and the credit side, cash at bankers, £6,775. 7s. 3d; cash on deposit at interest, £50,000; cash invested in Consols for parliamentary deposit, £25,000; and outstanding accounts, £100; total, £81,875. 7s. 3d. The chairman said that since they had met six months ago they had been actively engaged in continuing the work of the railway, and consequently there had been a considerable increase in the outlay of capital as compared with the previous half-year. The present rate of progress was satisfactory in all respects. There was, however, an interval of several weeks, when operations were wholly suspended on account of the severe frost. Good progress had been made with the tunnels, which had been driven entirely underneath the bed of the Thames, and for a length of 300 yards on the Surrey side and 120 yards on the Middlesex side of the river. Up to the 30th June 1,200 yards of single tunnel had been constructed. Towards Waterloo one tunnel was entirely in clay, but the down tunnel had at one place touched gravel. The compressed air, however, kept the water back. Water would also be touched nearer Waterloo, but the engineers were prepared for this. No damage whatever to buildings had been traced during the operations. Two electric locomotives were at work in the tunnels. There was a delay of about a week owing to the requirements of the District Railway Company, but this matter had been settled satisfactorily. With respect to terminal stations negotiations had been completed with the London and South-Western Railway Company for the Waterloo end, and negotiations with the City and South London Railway Company for the City station were in a forward state. All calls had been duly received, and the number of shareholders was now 541, against 494 at the last meeting. He congratulated the shareholders, engineers and contractors on the comparatively few difficulties which had been met with.

Lieutenant-Colonel the Hon. H. W. Campbell seconded the motion, which was adopted.

CROMPTON AND CO., LIMITED.

Directors: The Viscount Emlyn (chairman); Rookes Evelyn Bell Crompton, Esq., John Francis Albright. Esq (managing directors); Bernard Gibson, Esq.; Carleton F. Tufnell, Esq.

Seventh report of the directors, to be presented at the annual general meeting of the shareholders at the City Terminus Hotel, Cannon-street, E.C., on Friday, August 9, 1895, at 3 p.m:

The directors beg to report that the amount of the Company's business has again increased, but as will be seen from the accompanying statement of accounts made up to March 31 last the net profits show a considerable falling off in consequence of the further reductions in prices forced upon the Company With regard to the current year, it is satisfactory to state that the Company's order book is well filled, and the works are kept extremely busy, more so probably than at any previous time. The directors consider that a much healthier tone prevails in the business of electrical manufacturing, and they hope that there will now be a steady advance to better prices and better profits. The new debentures offered for subscription in January last were subscribed for to the amount of £82,850, which has provided additional working capital, and

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enabled the Company to materially reduce the bankers' loans. With regard to the cooking and heating department of the Company the directors are pleased to report that they have, since March 31, granted a license for the manufacture and sale of these appliances in France, the Company receiving £1,000 for the privilege and a substantial royalty on all sales. Negotiations are also in progress for granting licenses for other foreign countries. The net profits for the year amount to £6 953. 10s. 11d., and after providing for debenture interest and other payments there remains a net revenue balance of £2,343 15s. 9d , from which the directors propose to set aside £1,000 for contingencies and doubtful debts, and to carry the balance, £1,343. 15s. 9d.. forward. They further propose to transfer the sum of £1,000 from the reserve fund in reduction of the preliminary expenses account The seven years fixed by the purchase agreement of July 16, 1888, during which the Company secured the right to the services of Mr. R. E. Crompton and Mr. J. F. Albright as managing directors having expired, the Board have made arrangements for a continuance of their services. The directors regret to state that, in consequence of his having entered into other business engagements which necessitate his residing a long distance from London, Mr. H. H. J. W. Drummond has resigned his seat on the Board of the Company. In accordance with the articles of association, Mr. Bernard Gibson retires from the Board of Directors by rotation, but offers himself for re-election. The auditors, Messrs J. H. Duncan and Co., also offer themselves for re-election.

LIABILITIES AND ASSETS AT MARCH 31, 1895.

Capital and Liabilities	£ s. d.	£ s. d
Authorised issue 56,000 shares at £5		280,000 0 0
Ordinary shares 8,000 issued as fully paid	40,000 0 0	
Less 4,000 shares surrendered to the Company and cancelled by order of the Court of Chancery.	20,000 0 0	
	£20,000 0 0	
Ditto 1 928 shares, £1 called, £1,928; payments in full, £24	1 952 0 0	
		21,952 0 0
Preference shares, 28 180 at £5	£140,900 0 0	
Less arrears	33 0 0	
		140,867 0 0
		£162,819 0 0
Debentures issued £82,850, paid up		82 200 0 0
Ditto first issue outstanding		5,730 0 0
Loans from bankers		14,011 10 2
Sundry creditors		32 144 0 3
Half year's debenture interest, paid April 1, 1895		1,135 13 7
Doubtful debts and contingencies account		277 5 4
Reserve fund		2,135 4 6
Unclaimed dividends		41 2 9
Revenue account balance		2,343 15 9
		£302,837 12 4

Property and Assets.	£ s d.
Freehold property	21 382 19 8
Stock-in trade	56 198 2 2
Work in progress on contracts	7,289 15 10
Plant, tools, furniture, fixtures, etc.	48 815 0 0
Trade debtors	64,456 16 8
Investments in shares of other companies	3,409 10 0
Chelmsford Electric Lighting and other subsidiary companies	30,845 12 7
Cash at bankers and in office	12 101 12 5
Suspense account—preliminary expenses, premium on debentures paid off, and cost of new issue of debentures	9.777 3 0
Patents account	14,147 0 0
Electric cooking and heating department, cost of establishing	4,414 0 0
Goodwill	30,000 0 0
	£302 837 12 4

PROFIT AND LOSS ACCOUNT, YEAR ENDING MARCH 31, 1895.

Dr.	£ s. d.
Trading and office expenses, salaries, agencies, etc.	19 010 4 0
Repairs to buildings and plant	1,637 2 4
Depreciation of plant and machinery, patents and fixtures	4.763 16 8
Balance carried to revenue account	6,953 10 11
	£32,364 13 11

Cr.	£ s. d.
Gross profit from trading account, pupils' premiums, and dividends on investments	32,364 13 11
	£32,364 13 11

Dr. REVENUE ACCOUNT.	£ s. d.
Interest on debentures	2,565 18 7
Interest on bankers' advances	1,392 15 1
Directors', trustees', and auditors' fees	1,347 4 10
Income tax £342 9 4	
Balance available for distribution... 2,343 15 9	
	2 686 5 1
	£7,992 3 7

Cr.	£ s. d.
Balance from last year	1,038 12 8
Net profit from profit and loss account	6,953 10 11
	£7,992 3 7

BRISTOL TRAMWAYS AND CARRIAGE COMPANY, LIMITED.

The report of the directors for the half-year ended June 30 states that the gross receipts for the half-year amount to £42,820, and the working and general expenses and renewals are £33,177, leaving a net balance of £9,643, and it is proposed to pay a dividend at the rate of 6 per cent. per annum, free of income tax, for the half-year, carrying a balance of £2,415 to reserve and renewal funds. The investments which appear in the balance-sheet at cost price of £23,934 are at to-day's market value worth £25,500 The inclement weather during the early months of the half-year caused a falling off of upwards of £2,000 in the tramway traffic, but the larger portion of this was subsequently recovered, and the total decrease on the half-year amounts to £727 only. The business of the carriage department, however, shows a satisfactory increase of £787, the revenue from both departments, therefore, yielding an increase of £60. The construction of the city to Kingswood electrical line, and the conversion of the St George's depôt into a power station, are approaching completion, so that the tramway will be opened for public traffic within a few weeks.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Torrevieja.—Tenders are invited by August 20 by the municipal authorities of Torrevieja, Alicante, Spain, for the concession of the electric lighting of the town. The annual rental named is 4,000 pesetas for 100 16-c.p. incandescent and three 400-c.p. arc lamps.

Alexandria.—The municipal authorities of Alexandria, Egypt, invite applications by October 1, 1895 for the concession of the tramway lines from St. Catherine Place, through the outer boulevards, to the projected abattoirs at Mex, with a branch line. Security £E1,000.

Portsmouth.—Tenders are invited for laying about seven miles of stoneware ducts for electric cables required for the extension of the Corporation system. Specifications can be obtained at the station, Gunwharf-road, and tenders, addressed to the chairman of the Electric Lighting Committee, should be delivered there by 14th inst.

Berlin.—Tenders are invited for the supply of boilers for electric central stations of largest proportions, meeting the following requirements; high-pressure, very dry steam, minimum floor space, adjusting themselves to greatly variable steam consumption, easy cleaning, highest economy and efficiency, greatest possible safety against breakdowns. Apply to Allgemeine Elektricitäts-Gesellschaft, Schiffbauerdamm 22, Berlin, N.W., Germany.

Cowes.—Tenders are invited by the Urban District Council for laying down an electrical plant of sufficient capacity to keep burning at the same time 2,200 8 c.p. lamps, and also for public lighting and the laying of mains to accommodate 3,000 lights at the same time. The length of the road to be lighted is about a mile. Particulars can be obtained from Mr. Nelson F. Dennis, A.M.I.C.E., engineer to the Council, Cowes. Tenders are to be delivered by August 27.

Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

London, W.—The Hammersmith Vestry invite tenders for complete schemes for public and private lighting, and for the supply of motor power in that portion of the parish of Hammersmith described in the provisional order as the compulsory area. Memoranda of instructions, with a map of the district, may be obtained from Mr. H. Mair, surveyor to the Vestry, on or after July 10, 1895, between the hours of nine and five, Saturdays nine and one, on payment of a deposit of £10, which will be returned to persons sending in a bona fide tender. Tenders are to be delivered at the meeting of the Vestry, at the Vestry Hall, at 6.30 p.m. on September 4.

Sunderland.—The Corporation invite tenders for (*a*) high-tension and low-tension concentric cables; (*b*) cast-iron pipes and box frames and covers; (*c*) stoneware casing, boxes, and bell-mouth protectors; (*d*) high tension transformers for alternating current; (*e*) meters for alternating current. Specification, etc., can be obtained on payment of one guinea at the office of the borough electrical engineer, Electric Supply Station, Sunderland, on and after Monday next. The deposit will be refunded on receipt of the specification and conditions of contract with a *bonâ fide* tender. Tenders should be delivered at the town clerk's office by Monday, 26th inst.

Killarney.—The Commissioners for the Control of Lunatic Asylums, Custom House, Dublin, invite tenders for the electric

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wiring of the Killarney District Lunatic Asylum, the same to be connected to the supply mains (high tension) of the Killarney Electric Lighting Company. Forms of tender will be issued on application to the above Commissioners on deposit of £1, which will be returned to all persons who have sent in *bonâ fide* tenders on return of specification. The plans and specification can be seen at the asylum or at the office of the engineer, W. Leake, Esq., 30, Victoria-buildings, Manchester. Tenders are to be sent in by 30th inst.

Islington.—The Vestry are open to receive tenders for the wiring of the Vestry Hall and municipal offices in Upper-street, N., and for the supply of fittings. Specification, etc., can be obtained on application to the electrical engineer, Electricity Department, 50, Eden-grove, Holloway, N., after the 13th inst. Deposit of £1. 1s. will be required for the forms, but such deposit will be returned on receipt of a *bonâ fide* tender. The contractor whose tender is accepted will be required to pay his employés engaged on the work the trades' union rate of wages and observe trades' union conditions and hours of labour. He will also be required to enter into a contract and to find two sureties for the due execution of the work. Tenders must be sent in by 27th inst

Wakefield.—The Corporation invite tenders for the supply and erection of the following: Section A—boiler-house plant (boilers and fittings, mechanical stokers and engine economiser, feed-pump, injector, etc.); Section B—engine-house plant (steam alternators condensers, oil filter, fittings, etc, steam, exhaust, feed, blow-off, and sundry pipes, valves, and water-tank, etc.); Section C—main switchboard and instruments; Section D—underground work (cables, junction-boxes, culverts, and trenching, etc.); Section E—sub-station fittings (transformers and switchboard, etc.); Section F—arc lamps and posts; Section G—meters; and Section H—overhead crane. Particulars are obtainable from Mr. Robert Hammond, Ormond House, Great Trinity-lane, E.C., on and after August 2, on payment of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders are to be delivered by August 24.

Blackpool.—The following has appeared in the *Blackpool Gazette*: "We hear that at Friday's meeting of the Electric Lighting and Tramways Committee that there was an important discussion on the proposal to appoint Mr. Hammond as consulting engineer for the tramway system in addition to the electric lighting works. We are informed that considerable objection was raised to this appointment, and we hope that the strongest reasons will be demanded and be forthcoming before any proposal of the sort is sanctioned by the Town Council. We are told that between March, 1894, and March, 1895, Mr. Hammond received no less than £600 in fees from the Blackpool Corporation in connection with his position as consulting engineer to the electricity works. If this is the case, we certainly think the ratepayers have every reason to object to this gentleman's powers locally being enlarged. We don't doubt Mr. Hammond's ability in the slightest, but at the same time we should like some statement from him as to whether he is responsible for the enormous expenditure on the electricity works—a matter which we claim should be fully gone into before next November. If all we hear be true, the tremendous cost of the Blackpool electricity works is a disgrace of no small magnitude to every member of the Town Council, and we shall be greatly mistaken if the ratepayers do not declare their opinion with no uncertain sound when opportunity offers. If Mr. Hammond received £600 last year he is the best paid official among the Corporation staff, and it would be interesting to know exactly how much time he devoted to the interests of the Blackpool ratepayers for this large amount. Then what are we to think about the abilities of Mr. J. Hesketh, who receives £250 per annum as electrical engineer, but whose opinion the Electric Lighting Committee evidently deem of such little worth that they require to consult Mr. Hammond so frequently as to run up fees to so large a total as £600. It seems to us that the affairs of the electricity department require overhauling from top to bottom, with a view of the ruinous expenditure of the past being accounted for, and a more business-like system adopted than having a 'consulting engineer' at £600 and an 'electrical engineer' at £250 to manage a concern of such dimensions."

RESULTS OF TENDERS.

London, W.—The St. George's, Hanover-square, Vestry have decided to light the Vestry Hall and offices by electricity, and have accepted the tender of Messrs. Strode and Co., at £278. 5s., for the work.

Aberdeen.—The Sites and Plans Committee of the Aberdeen University Court have reported the acceptance of contract for the installation of the electric light in the new halls and north block anatomical rooms, the successful offerers being Messrs. Shirres, Laing, and Co., and the estimate being £670.

London, E.C.—The following tenders have been received by the Shoreditch Vestry for the erection of a chimney shaft 150ft. high:

W. Neil, 165, Turner's-road, Bow	£3,420
Yates and Co., 223, Westferry-road, Millwall	3 270
Myles and Warner, 28. Burnard-place, Holloway, N.	3,167
Manlove, Alliott, and Co., Gracechurch-street (accepted)	2,683

London, S.W.—The General Purposes Committee of the St. James's Vestry have been considering the advisability of lighting the Town Hall by electricity, and instructed the Vestry's surveyor to bring up a specification and obtain tenders for the necessary work to be carried out. Three tenders for the work were received as follows: Freeman and Co., £39; C. J. Smith, 23, King-street, £38. 15s.; and Verity and Sons, £45. 7s. 7d. The tender of Messrs. Freeman was accepted.

Salford.—The following tenders have been received by the Salford School Board for the electric lighting of new offices. Mr. S. V. Clirehugh, A.M.I.C.E., A.I.E.E., Manchester, is the electrical engineer:

Wiring.			
Bennett and Druce	£311	0	0
Brush Electrical Engineering Company	430	0	0
Corlett Electrical Engineering Company	282	0	0
Donnison, Parmiter, and Barber	217	3	0
Drake and Gorham	262	0	0
E. J. Dugdill and Co.	246	0	0
J. A. Edmonson	244	6	7
S. H. Heywood	247	10	0
Liverpool Gas Fittings Company, Limited	270	10	0
Lowcock, Hill, and Co.	290	15	7
Lund Bros. and Co.	197	0	0
Mercier, Maunsell, and Co.	260	0	0
Northern Counties Electrical Engineering Company	244	12	6
Paterson and Cooper	230	0	0
F. H. Royce and Co., Limited	285	0	0
Russell and Lennard	297	10	0
B. Verity and Sons (accepted)	205	0	0
Warings, Limited	295	0	0
Electric Bells.			
Bennett and Druce	24	0	0
Brush Electrical Engineering Company	16	0	0
Corlett Electrical Engineering Company	25	0	0
Donnison, Parmiter, and Barber	18	0	0
Drake and Gorham	14	10	0
E. J. Dugdill and Co.	12	0	0
J. A. Edmonson	9	16	0
S. H. Heywood	14	6	0
Liverpool Gas Fittings Company, Limited	9	10	0
Lowcock, Hill, and Co.	23	11	5
Lund Bros. and Co.	18	0	0
Mercier, Maunsell, and Co.	14	0	0
Northern Counties Electrical Engineering Company	12	18	0
Paterson and Cooper	13	7	6
F. H. Royce and Co.	45	0	0
Russell and Lennard	10	17	0
B. Verity and Sons (accepted)	10	0	0
Warings, Limited	12	10	0
Speaking-tubes.			
Bennett and Druce	4	0	0
Brush Electrical Engineering Company	6	10	0
Corlett Electrical Engineering Company	10	5	0
Donnison, Parmiter, and Barber	10	12	6
Drake and Gorham	10	10	0
E. J. Dugdill and Co.	6	0	0
J. A. Edmonson	5	18	0
S. H. Heywood	8	0	0
Liverpool Gas Fittings Company, Limited	3	0	0
Lowcock, Hill, and Co.	9	14	4
Lund Bros. and Co.	14	10	0
Mercier, Maunsell, and Co.	10	0	0
Northern Counties Electrical Engineering Company	4	18	6
Paterson and Cooper	8	15	0
F. H. Royce and Co., Limited	11	0	0
Russell and Lennard	10	9	0
B. Verity and Sons (accepted)	6	0	0
Warings, Limited	5	0	0

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,930.

Eastern Telegraph Company.—The receipts for the month of July were £61,413, as against £56,753 for the corresponding period of 1894.

Direct Spanish Telegraph Company.—For the month of July the receipts were £1,889, as against £1,400 for the corresponding period of 1894.

West India and Panama Telegraph Company.—The receipts for the half month ended July 31 were £1,830, as against £1,762 for the corresponding period.

Eastern Extension Telegraph Company.—For the month of July the receipts show an increase of £4,682 as compared with the corresponding period of 1894.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 4th inst. amounted to £1,355, as compared with £1,000 in the corresponding week of last year, being an increase of £355.

Aberdeen.—The Town Council have remitted to the Gas and Electric Lighting Committee for consideration a letter from the City of London Electric Lighting Company as to a proposed amendment of the Electric Lighting Acts.

Railway-Lighting.—At the half-yearly meeting of the London, Tilbury, and Southend Railway the chairman, Mr. H. Doughty Browne, said that the directors contemplated improving the lighting of the carriages by the use of the electric light.

Bradford.—At the last meeting of the Bradford Gas and Electricity Committee of the Town Council the coal contracts for the year were given out. Tenders for 129,000 tons of ordinary gas coal and also for 28,000 tons of cannel coal were accepted.

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Leipzig Tramways Company.—The directors have declared an interim dividend on the ordinary and preference shares at the rate of 4½ per cent. for the half-year ended June 30.

Asbestos.—The United Asbestos Company, Limited, of Dock House, Billiter-street, London, E C., inform us that they have been awarded the contract for the supply to the Admiralty of asbestos packing and other goods for the ensuing year, 1895-6.

Church-Lighting.—Electric lighting is to be introduced into Westminster Abbey, the organ loft being treated first, at any rate experimentally. The organ-loft at Westminster Abbey is in the screen, a dark place even on the lightest days, and it is at present lit by gas.

Liverpool.—The City Council on Wednesday adopted the report of the committee who were empowered to negotiate the purchase of the undertaking and business of the Liverpool Electric Supply Company, Limited. The full report of the committee appears elsewhere in the present issue.

City and South London Railway.—The returns for the week ending August 4 were £804, compared with £849 for the corresponding period of 1894, being a decrease of £45. The total receipts for the half-year 1895 are £4,224, as compared with £4,306 for the corresponding period of 1894, being a decrease of £82.

Barmouth.—With reference to our "Business Notes" *re* Barmouth in our issues of July 26 and August 2, Mr. George T. Pardoe, Littlehampton, informs us that he had previously made proposals to the Barmouth Urban District Council with reference to electric lighting. He proposed that the Council should use water power.

House-to-House Electric Light Supply Company, Limited.—The directors of this Company have declared an interim dividend on the preference shares for the half-year ending June 30 at the rate of 7 per cent. per annum. The dividend is payable on the 26th inst. The transfer books of the Company will be closed from 16th till 26th inst, both days inclusive.

Country-House Lighting.—We understand that Messrs. Drake and Gorham have in hand a considerable amount of this class of work in the neighbourhood of Crewe. Major Kearsley, of Stapeley House, has instructed them to put down a multitubular boiler of 14 h.p. to drive a No. 6 Parker dynamo; there will be a battery of 53 cells of the D.P. Company's make.

Dewsbury.—A meeting of the Town Council was held on Tuesday, Alderman Pyrah presiding. Alderman Robinson, chairman of the Lighting Committee, reported a large increase in the consumption of gas, despite the extending use of the electric light, as supplied by the Corporation, and this was regarded as very satisfactory. Both these facts told of the prosperity of the town, which he hoped would long continue.

Portsmouth.—The Roads and Works Committee of the Portsmouth Town Council have deputed their chairman and vice-chairman to accompany Mr. A. W. White to Bristol to inspect the works connected with the establishment of an electric tramway at that place. This proceeding has been taken in view of a proposal to utilise the current now generated at the borough electric lighting station in the daytime to propel the cars on the Lake-road line, when the tramway is relaid on the completion of the drainage works now in progress.

Aberystwith.—A meeting of the Public Lights Committee of the Corporation has been held, when it was agreed to recommend the Council to remove the electric lamp in Great Darkgate-street which at present lights Market-street. It was decided to ask the electric light company if they would modify their charge per lamp for the use of an extra six lamps during the months of July, August, and September. The committee also decided to report to the Council that it was agreed to defer the question of placing two lamps on the Penparke-road for a couple of months.

Longton.—At the last meeting of the Town Council a draft agreement between the North Staffordshire Tramways Company and the Corporation with reference to the alteration of the date upon which the Corporation can compulsorily purchase the tramways in the borough from eight years to 22 years, and to sanctioning the working of the tramways by electricity by means of overhead wires, was read by the town clerk. It was stated that the same agreement was being submitted to the other local authorities in the district. On the motion of Mr. Brookfield, the agreement was approved.

Glasgow.—A meeting of the Town Council was held on Thursday last week, at which Councillor Mitchell, the new convener of the Gas Committee, submitted the annual report on gas supply and electric lighting. In the electrical department the committee regretted that a profit had not yet resulted. No doubt this state of matters would be altered in the near future, and the plant at Waterloo-street and John-street was expected to be fully occupied during the coming season. Meantime, the committee did not propose to alter the price of 6d. per Board of Trade unit, at which electricity was at present supplied. The report was adopted.

St. Helens.—At a meeting of the Electric Lighting Committee of the St. Helens Corporation the following tenders for the supply of the plant for providing electric lighting in the borough were accepted, subject to the approval of the Local Government Board: boiler-house plant, Yates and Thom; engine house plant, Johnson and Phillips; switchboards, S Z de Ferranti; underground work, British Insulated Wire Company; transformers, John Fowler and Co.; meters, Chamberlain and Hookham; travelling crane, Carrick and Ritchie. The committee instructed the town clerk to apply to the Local Government Board for sanction to borrow £10,000 for carrying out the works in question.

Tunbridge Wells.—At Wednesday's meeting of the Town Council, the Town Clerk reported to the Lighting Committee that he had received from Mr. Preece a plan showing the positions of the mains to be laid on the Pantiles as finally decided upon, and had forwarded the same to Messrs. Burn and Berridge on behalf of the lady of the manor, at the same time stating that the plan was submitted without prejudice. It was resolved to instruct the engineer to proceed with the works on hearing from Messrs. Burn and Berridge, and also to proceed with the construction of the transformer-chamber between the Pantiles and the Pump-room.

I E S Accumulator Company, Limited.—This Company has been registered by J. L Higgs, 43, Finsbury-square, E.C., with a capital of £100,000, to carry on business as manufacturers of and dealers in electric storage batteries; as electrical engineers and electricians, mechanical engineers, producers and suppliers of electricity for light, heat, or motive power; as manufacturers of and dealers in electrical apparatus and appliances; to supply accumulators for the purpose of lighting omnibuses, tramcars, cabs, and other vehicles, public or private buildings, manufactories, mines, ships, lighthouses, railways, etc.; to establish and maintain telegraph, telephones, electric bells, phonographs, etc.

Southborough.—At the last meeting of the Urban District Council the clerk read a letter from the Guildford Electricity Supply Company, Limited, of 34, Victoria-street, Westminster, who gave notice that they intended to make application, on or before December 31, by memorial to the Board of Trade, in pursuance of the Electric Lighting Acts, 1882 1888, for a provisional order, to be confirmed in Parliament in the ensuing session, whereby they might supply electricity for public or private purposes within the area of the Southborough Local Authority. The Chairman stated they had a similar communication last year, and they opposed the proposal. They would oppose the application at the proper time.

Ipswich.—At Friday's meeting of the Lighting Committee of the Town Council, the Town Clerk said he had received a formal notice that the County of London Brush Electric Lighting Company, Limited, intended before December 21 to apply for an electric lighting order for Ipswich. The Chairman supposed the only thing the committee had to do was to report the fact to the Council. The Town Clerk said there would be time enough when the company made the formal application for the order. In many cases this notice was given and the matter went no further. Mr. Josselyn observed that no authority had been given by the Council to the committee in reference to electric lighting. The matter then dropped.

Copper.—Messrs. Henry R Merton and Co's copper statistics show that the visible supply was slightly smaller at the end of July than a month previously. The total stocks in England and France and afloat now amount to 57,817 tons, against 58,182 tons on June 30, the deliveries during the past month having exceeded the supplies by 365 tons. The satisfactory feature in the case, which points to higher prices for copper, is the fact that the excess of deliveries was, in spite of arrivals from the United States, larger than in any month since December, 1893. Should the supplies from the United States decline during the next few months, as is expected in well-informed quarters, there will certainly be a further substantial advance both in the metal and the shares of copper companies.

Leeds.—The Yorkshire House-to-House Electricity Company are about to make a large extension of their mains, by which the electric light will be brought within reach of the residents of Chapeltown and the occupiers of business and other premises along the important thoroughfares *en route*. The existing mains terminate in New Briggate, and it is now intended to carry them along North-street and Chapeltown-road and Harrogate-road, as far as the tram terminus. The necessary preparations having been made and plans deposited, the work will be put in hand almost immediately, and it is expected that the supply of current will be available at an early period of the autumn. Already a considerable number of residences and business establishments are being fitted up to receive the light.

Mersey Railway Company.—The report of the directors of this Company states that after the date of the last half-yearly meeting the directors made a further enquiry into the important matter of working the railway by electricity, or other motive power, and decided to proceed with the Company's Bill in Parliament for the necessary powers. The Bill has passed the committee of the First House. Owing to the unfavourable response of the debenture stockholders and the proprietors in regard to raising £50,000 further capital and to the "scheme," the clauses in the Bill relating thereto were withdrawn. Valuable as the Bill may prove to be, the directors remind the shareholders and the debenture stockholders of the great necessity for a scheme, either in Chancery or under Act of Parliament, being agreed upon, so that money may be raised when necessary as cheaply as possible.

Ossett.—A meeting of the Town Council has been held at which a resolution was passed in favour of the promotion of a Bill for the purchase of the undertaking of the Ossett Gas Company. Councillor Lucas said that a scientific gentleman (?) had told him it would be very unwise to purchase the gasworks, and that the electric light six months hence would be quite a different thing to the electric light of to-day. Alderman Mitchell, however, did not fear that gas would be superseded. It was a very useful commodity, and when the electric light was perfected as far as it could possibly be, there would still be room for gas and electric light. Councillor Phillips did not think there would be a larger consumption of gas, because electric light was making rapid strides. Alderman Lucas considered that electric light was the light of the future, even in

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Ossett, and the use of the electric light must curtail the consumption of gas.

Acton.—At the last meeting of the District Council it was reported that the Capital and Counties Electricity Supply Company had acknowledged the receipt of the clerk's letter, stating that the Council would oppose their application to the Board of Trade for a provisional order empowering them to supply electric light and power in Acton. A letter was also read from the City of London Electric Lighting Company suggesting that the Council, as the undertakers under an electric lighting provisional order, should co operate in an endeavour to alter the existing law in a respect in which it operated harshly towards such undertakers. The communication was referred to the Works Committee without comment upon its subject. Mr. Terriss, of Bedford-park, having written asking when electric light would be available in the parish, the Works Committee recommended that he be informed that there was no immediate prospect of electric light being brought into the district

Wimbledon.—At the Urban District Council's meeting on the 31st ult. the Lighting Committee recommended the adoption of Mr. Arthur Preece's electric lighting scheme, which we give *in extenso* in another column and that the Local Government Board be asked to sanction a loan of £32,000 to carry out the same The Chairman said the working expenses were estimated at £2,475 per annum and the interest and repayment on the loan £1 700, making the total liabilities over £4,175 per annum. As a set-off to that there was the cost of lighting the public lamps with oil (£1,800), meter rents were estimated to produce £75, and if the public would take 3,500 lamps at 10s. each it would leave an apparent deficiency of £550. Mr. Preece had not, however, taken into account the £150 which the Council at present paid for their office, etc., and which, perhaps, would be included in the private lighting estimates. Mr. Preece considered the response of householders very satisfactory. The recommendation was adopted unanimously.

St. Pancras.—The Vestry have appointed Messrs. Burnett and Hooper as electricians at the King's-road station The Works Committee have brought up a report again recommending the Vestry to refuse sanction to the London Hydraulic Power Company to lay pipes in the parish. The chairman of the committee expressed himself as opposed to the recommendation, and said he understood that the Hydraulic Company was prepared to give an undertaking not to use their power to promote electricity. Mr. Sweet, the chairman of the committee, said that from the first moment that the Vestry decided to adopt electricity it was well understood they should never allow any rival competitors or any other power into St Pancras. That was the main idea which operated with the committee when the subject was first broached. They had the sole electric lighting and motive power in the parish, and they wanted to keep it. In the end the Vestry decided, by 34 to 30, to refuse the application, in accordance with the recommendation of the committee.

Gloucester.—At the last meeting of the Town Council Mr. Alderman Holtham called attention to the minute which stated that the town clerk reported that he had received from Messrs. Walter Webb and Co., London, on behalf of the Great Western Electric Light and Power Company, Limited, formal notice of their intention to apply to the Board of Trade for a provisional order to supply electricity for public purposes within the city. It would be within the recollection of the Council, Alderman Holtham remarked, that applications had been received on several occasions for the Council to supply electricity He would suggest a harmless proposition that a small committee be appointed to make the necessary arrangements so as to meet the wishes of the applicants. Mr. Councillor Clutterbuck seconded, and remarked that he considered it highly desirable to consider the matter. When the time was ripe there could be no question as to whether the people would take up electricity in the proper spirit. The Deputy-Mayor suggested that the matter should be referred back to the Finance Committee. The Mayor agreed with this proposition, and it was carried.

Croydon.—The Electric Lighting Sub-Committee of the Croydon County Council reported at the last meeting of that body that they had carefully considered the question of the exact position of the central electric lighting station. It was at first contemplated that the station should be placed upon a portion of the allotment land, but it was subsequently considered that it would be better to place the station upon the land belonging to the Corporation at Brimstone Barn. In either case it was contemplated that a siding should be constructed from the railway on to the site of the station. It appeared, however, that there would be considerable expense, and that there were other difficulties which rendered a siding impracticable. Under those circumstances the sub-committee looked about for another site, and suggested that three acres of land should be purchased in Factory-lane, nearly adjoining the Albion Works. Upon this suggestion of the sub committee the committee recommend that the land proposed be purchased at the price and upon the conditions that will be mentioned by the chairman to the Council *in camera*. The purchase-money will be provided out of the loan for which sanction has been sought.

Wrexham.—The Town Council at its last meeting received a letter from the Board of Trade with copy of an application from the Wrexham and District Electric Supply Company, Limited, applying for a further extension of time, and stating that, subject to any observations which the Corporation might wish to offer, the Board of Trade proposed to defer consideration of the question of the revocation of the order for a further period of six months from August 15. Alderman Bevan moved and Mr. Charles Davies seconded that the Council offer no objection to the course which the Board of Trade proposed to take. Mr. Thomas Jones thought the time had come when the Council should put a limit to such applications. He understood that the company had not paid the £500 required, and that some of the shareholders were refusing to pay calls, so that the whole thing was in a collapsed state. He did not think they could give away any more time. Mr. Benson pointed out that if the resolution were passed the Council would be tying its hands for six months. Alderman Bevan said there was a great deal in what Mr. Thomas Jones said, and he would amend his motion to the effect that the Council would not object to the extension on condition that it was the last. This was agreed to and the motion was carried.

Toxteth Park.—Mr. John Price, A.M.I.C.E, engineer and surveyor to the Urban District Council of Toxteth Park, has issued his annual report for 1894-95. He states that during the year electric lighting mains were laid, under the supervision of the electric inspector, in Croxteth-road, Ullet-road, Greenbank-drive, and Lathbury-lane. The number of houses supplied with the electric light at the end of the year was 38, being only an increase of nine for the 12 months During the year the Liverpool Electric Supply Company gave notice of their intention to apply to the Board of Trade for a new provisional order, to amend the existing orders, in case of the incorporation of the Council district. In connection with the refuse-destructor works which have been erected, after receiving reports upon the relative cost of lighting the works by gas or electricity, it was decided to adopt the latter method, the necessary power being already provided. Mr. W. G. P. Macmuldrow, the electric inspector to the Corporation of Liverpool, was called in to advise as an expert, and, upon his report, it was decided to contract only for the supply of the engine and dynamo, the rest of the work being carried out departmentally. The contract for the engine was let to Messrs. Ransome, Sims, and Jefferies, of Ipswich, and for the dynamo to the Electric Construction Company, of Wolverhampton.

Blackburn.—At the last meeting of the Town Council the minutes of the Town Hall and Public Baths Committee stated that the town clerk had submitted the tenders received for the electric lighting of the Town Hall. The committee resolved, and it was sanctioned by the Council, that it be an instruction to the town clerk to have the tenders tabulated and printed and a copy forwarded to each member of the committee, and that the consideration of the tenders be deferred to a future meeting of the committee. In referring to the minutes of the Gas Committee, Mr. E. Hamer said that it would not be wise to refuse applications for the electric light. They had had applications for 1,500 lamps, and it would be well for all purposes if the minute of the committee was referred back. In a road like Preston New-road the inhabitants would be having the light from some other source if the Corporation refused applications. That should not go forth, and he moved that the minute be referred back. Mr. Oddie seconded, and during the course of further discussion it was thought that the present system should first be thoroughly tested before they went in for extension. Alderman W. Thompson, contending that there would be no harm in referring the minute back, said one statement made by one speaker was wrong to the extent that it would not cost as much to put up the proposed light per lamp as the installation they had now. Alderman Harrison did not think that 1,500 lamps would be applied for. The amendment was ultimately carried.

Edinburgh —The public electric lighting system of the Corporation has been extended as far east as the foot of Canongate, and as far south as Hope Park, and in the case of Canongate particularly the turning on of the new illuminant created a good deal of interest. At a quarter to nine o'clock on the night of the inauguration about 200 residents in the Canongate Ward assembled in the Canongate Institution, under the chairmanship of Councillor Waterston and heard a few remarks from that gentleman, and also from Councillor Mackenzie, convener of the Electric Lighting Committee, prior to repairing to the thoroughfare outside and witnessing the turning on of the current. Councillor Waterston in his remarks spoke of the boon the new light would be to the inhabitants, and stated that in view of the nature of the street and the character of its buildings, the Canongate would be one of the best lighted thoroughfares in the kingdom. Councillor Mackenzie, on his part, expressed his pleasure at seeing this latest extension of the new light, and mentioned that so far as it had gone the Edinburgh installation was one of the most successful that was to be seen anywhere in the kingdom. Since the light was turned on in the city on April 11 it had never been off the mains for a single second. There had never been a hitch. Votes of thanks were accorded to the ward representatives and to Councillor Mackenzie. When the company adjourned to the street they found a crowd of several hundred people gathered outside the hall to watch the light turned on.

Fulham.—At the last meeting of the Vestry the Special Committee on the electric lighting of the parish, etc., reported as follows: "Before taking any further steps in the matter of electric lighting we have instructed the clerk to request the various local authorities who have had the electric light installed in their districts to furnish this Vestry with the best information they can give upon the following points: (1) The number of shops and other places of business within the area of supply and the number of such shops and places of business taking the light; (2) the number of private houses in the area of supply and the number of such houses taking the light. This information to be supplied, if possible, in a tabular form showing the ratable value of the shops and houses supplied, thus (1) ratable value below £40; (2)

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between £40 and £50; (3) between £50 and £75; (4) between £75 and £100; (5) between £100 and £150; (6) between £150 and £200; and (7) above £200. (3) As to public lighting: (*a*) length of roads lighted; (*b*) the system of gas lighting in use and its cost previous to the adoption of the electric light, including all expenses; (*c*) the amounts charged to the local authority for lighting the same roads by electricity and the number and kind of lights used." Mr. Comben moved as an amendment that the committee's report of July 17 be adopted. This was seconded by Mr Marks. The amendment was lost, four voting for and nine against. Mr. Sayer proposed another amendment that the matter be referred back for the committee to select three electrical experts and recommend the Vestry that one be appointed. This amendment was also defeated, six voting for and 18 against. The report was then adopted.

Kingston-on-Thames.—At the last meeting of the Town Council, the Town Clerk reported that the Local Government Board had sanctioned the borrowing of £7,772 on the electric lighting account for a term of 25 years instead of 15 years, to which it was originally limited. It was decided to seal a mortgage to Parr's Banking Company for the loan of this sum at 3¼ per cent. The Lighting Committee reported that the electrical engineer had been instructed to submit an estimate of the cost of wiring the sewage works for the electric light, and for supplying current, and that the town clerk had been directed to enquire whether Surbiton and Hampton Wick were prepared to be supplied with current from the Kingston electric lighting works. The Surbiton District Council replied stating that they proposed to have their own electric works. The town clerk was told to inform the Malden District Council that the Corporation would supply Coombe with the electric current on the necessary arrangements being made. The Engineer stated that the receipts for the supply of electricity and for meter rents for the half-year ending June 30 were £731. 4s. 1d. compared with £336. 10s. for the corresponding half last year. The committee had resolved: "That, subject to the approval of the Council, consumers of electric current be offered the following arrangements in regard to their payment for current—namely, that the present price of 6d. per unit be charged until the consumer has consumed sufficient current to average a daily use for two hours of the number of lamps he has had burning simultaneously, and that all additional current consumed be charged for at a reduced price of 4d. per unit—that is, one third less, it being found that a similar arrangement has worked advantageously both to the consumer and to the producer in other towns, such, for instance, as Brighton."

Blackpool.—The Corporation are prepared to receive tenders for the right of user for a period of seven years of the tramways in Lytham-road in the borough, authorised and constructed under the Blackpool Corporation Tramways Order, 1893. These tramways extend northwards from the southern boundary of the borough, and are about two miles in length. The motive power will be required to be electrical, and the systems to be used must be an approved overhead wire and trolley system from the southern boundary of the borough to the northerly side of Station-road, and for the remainder of the route the electrical conduit or centre-channel system now laid down by the Corporation in the roadway. The lessee must provide the plant required for generating the electrical energy, also all carriages for working the tramways and all appliances for the overhead wire and trolley system along the portion of route to be worked thereby, but he will allowed to use the electrical conduit or centre channel in the remainder of the route. The Corporation will reserve to themselves and any of their lessees of their other tramways in the borough, now or hereafter laid, the right of user of the portion of tramways in Lytham-road from Station-road northwards, including the electrical conduit or centre channel, and demanding and taking toll thereover, and the lessee must perform, observe, and comply with all requirements of the provisional order, and of all Acts of Parliament and by-laws from time to time in force affecting the tramways, and which ought to be performed, observed, and complied with by the lessee. The lease will be prepared by the town clerk of Blackpool, and will contain usual and proper provisions for the working of the tramways by the lessee, and will be subject to the approval of the Board of Trade. Tenders, under seal, stating the amount of the proposed annual rent, and endorsed "Lytham-road Tramways," to be delivered to the town clerk by the 17th inst.

Cardiff.—A meeting of the Cardiff Free Library Building Committee was held on Friday, presided over by Alderman David Jones. The architect (Mr. Seward) presented tenders and designs for electric light fittings for the free library. It appeared that some of the designs had not been discussed between the chief librarian (Mr. Ballinger) and the architect, and the committee could not, therefore, come to any decision on the matter. The question of the number of fittings for the tables was the chief matter for consideration. The Librarian said the matter could be disposed of in a quarter of an hour, and the Chairman then rose saying that he would vote that the committee retire for a quarter of an hour while the librarian and architect settled the matter. The committee having retired some slight modification in the designs was made, and on the reassembling of the committee the tenders were opened. On the proposition of Alderman Rees, the tender of Messrs. Thomas Brown and Co., of 64, Clement-street, Birmingham, was accepted. A meeting of the Corporation Finance Committee was held on the 1st inst. at the Town Hall to consider the estimates of the various committees, in respect of which a general district rate is to be made to cover the expenditure for the six months from September 30 next to March 31, 1896. The Lighting and Electrical Committee's estimate for street-lighting for the 12 months was: for gas, £5,400; electric light, £900; labour, £2,650; materials, etc., £400; making with other items a total of £10,029. Under the head, electric lighting also for twelve months, appeared the following items: labour, £2,305; coal, stores, etc., £1,200; carbons for arc lamps, £200; rent of depôt in town, £52; water, £100; insurance of men, boilers, and buildings, £25; printing, advertising, and stationery £50; contingencies, £200; making a total of £4,132 less £2,700, estimated revenue the balance of £1,432 added to the £10,029, representing a total of £11,461.

Dover.—At the Town Council's last meeting a report from the Lighting Committees of the Town and Pier Wards on the position of the electric lights in Snargate street was due but not forthcoming. Councillor Thorpe explained that as the notice received from the town clerk contained a paragraph in which it was stated that the experienced officials of the electric light company would fix the exact locality of each lamp, as their experience would enable them to do this to the best advantage, they did not see the use of the committee meeting. He also pointed out that the agreement with the company threw on the Corporation the onus of obtaining leave from the owners to put up the arches. He gave notice that he should move that the resolution passed in reference to the lighting of Snargate street by electricity be rescinded. If they had to find the sites, no doubt the owners would want paying, and it was altogether too much, considering the excessive charge of £30 per lamp. He asked if they were in a position to spend that money. The 21 lamps they already had cost them £650, and the 10 more £300. He wished to know why the gas company had not been asked to send in a price to compete with the electric light. At present they had 24 lamps at a cost of £5. 1s. each, and if they were to have the incandescent burners similar to Maison Dieu-road, it would only cost £3. 15s. He should propose to increase the lamps to 32, when the cost would be the same, and they would have an equal light to what the electric light would give. Alderman Peake said that it was a snatch vote by which they decided to pay the £300. He thought it could be spent for better purposes, and although he spoke as a gas director, he also spoke as a ratepayer, and his remarks would receive a good deal of support outside. A letter was also read from the electric light company asking for an appointment to meet the Lighting Committees of the wards. A long discussion took place, in which Councillors Clark, Mackenzie, and G. Mowll took part, but no conclusion was arrived at, Councillor Thorpe's motion in the meantime having stopped any further steps.

Edison and Swan United Electric Light Company, Limited.—An extraordinary general meeting of the Edison and Swan United Electric Light Company, Limited, will be held at the offices of the Company, Ediswan Buildings, 36 and 37, Queen-street, Cheapside, in the City of London, on Friday, August 16, 1895, at one o'clock in the afternoon, when the subjoined resolution, which was duly passed at the ordinary general meeting of the Company held on July 29, 1895, will be submitted for confirmation as a special resolution under the Companies Acts—viz., "Resolved that the articles of association of the Company be altered by striking out Article 87 and substituting therefor the following articles: 87. The amount from time to time declared by the Board as available for dividend, including the amount, if any, recommended by them to be withdrawn from reserve for equalisation of dividends, shall be applied as follows: (1) There shall be first set aside thereout a sum equal to a preferential cumulative dividend of 7 per cent. per annum on the aggregate amount for the time being paid or credited as paid on the A shares. (2) Out of the sum so set aside there shall be paid a preferential cumulative dividend at the rate of 5 per cent. per annum on the amounts paid or credited as paid on the A shares without distinction. (3) Subject thereto there shall be paid out of the sum so set aside a further cumulative dividend at the rate of 2 per cent. per annum on the amount paid or credited as paid on the A shares provided that until all the A shares be fully paid no A share, whether fully paid or not, shall for the purpose of this sub-section be deemed to have paid upon it more than the amount paid up or called up upon the A shares for the time being having the least amount called up or paid thereon. (4) The balance of the sum so directed to be set aside shall be carried to the reserve fund. (5) The residue of the amount declared to be available for dividend after setting aside the sum mentioned in Sub-section 1 shall be applied in payment of dividends *pari passu* on the amounts paid up or credited as paid on the A and B shares, but so that for the purposes of this sub-section the amounts to be deemed paid up on the A shares shall be ascertained, as in the case of Sub-section 3."

Derby.—A Local Government Board enquiry has been held by Colonel Wm. Ducat into the application of the Corporation to borrow £13,000 for electric lighting purposes. The Board have already sanctioned £35,000, and the additional money is required for the actual expenditure above the sum previously granted. At Wednesday's meeting of the Town Council, Alderman Leech moved the adoption of the report of the Electric Lighting Committee, which was as follows: "The Council on March 6, 1895, granted the sum of £5,000 for works, etc., as under: alteration of premises adjoining the station, £1,000; additional distributing and connecting mains, £2,000; three additional boilers, £2,000; total, £5,000. The committee have had specifications prepared and have invited tenders for building boiler seatings for the three new boilers and for building the new coal-store at the station, and the tender of Mr. George Wagg (£1,965) has, subject to the approval of the Council, been accepted. The committee have also ordered an additional flue to the three boilers which are now being constructed at a cost of £80. The cost of the three boilers is £1,479. 15s. Assuming that the £2,000 for

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mains is sufficient, it will be seen that a further sum of about £524 will be required to complete these works. The Council is asked to grant the sum of £524, and to direct application to the Local Government Board for the borrowing thereof. In consequence of the still rapid increase in the demand for electricity, the committee have had under their consideration the desirability of enlarging the present station so as to cope with the supply, and it has been decided to recommend the Council to grant a sum of £3,490 to enable them to build an annexe to the present station and to provide a 250-h.p. engine and alternator with exciter, including steam-pipes and all connections and additions to the switchboard. The Council is requested to pass the resolution placed upon the agenda, granting the amount, and directing application to the Local Government Board for the borrowing thereof. The committee have taken charge of the lights in the Market Hall for the Markets Committee, and of the lamps outside the Town Hall for the Estates Committee. The Employers' Liability Company, Limited, have paid the sum of £50 in full discharge of all claims in respect of the death of Samuel Woollatt, one of the arc lamp trimmers, who was killed by falling from an electric light lamp. The amount has been paid to the deceased's administratrix. The committee beg to report that the borough accountant, acting upon their instructions, has prepared a capital and revenue account of the electric lighting undertaking." The report was adopted after discussion.

Brighton.—The borough surveyor has presented a report to the General Purposes Committee of the Town Council with regard to the proposed passenger lift at the Town Hall, pointing out that there were two kinds of lifts in use—viz, those worked by hydraulic power and others worked by electric current. The electric lifts were very generally adopted now instead of hydraulic lifts, and they frequently superseded existing hydraulic lifts. The cost of a hydraulic lift, suitable for use in the Town Hall, would be £357. The cost of an electric lift of the same capacity would be £538. The cost of working a hydraulic lift with water would be slightly less than the cost of working an electric lift with electricity, but in either case, assuming that the lift would make from 150 to 180 journeys a day, the cost would not exceed about £10 a year. The cost of maintenance would be about the same in either case. There were upwards of 2,000 lifts worked by electricity in this country at the present time, and recognising the value of electricity as a motive power, he strongly recommended the Council to adopt an electric lift for use in the Town Hall. The committee resolved that the borough surveyor be instructed to provide an electric lift for the Town Hall at an estimated cost of £538. Alderman Reeves, in moving the adoption of the proceedings of the committee at the last meeting of the Town Council, said he had been asked to give some explanation as to the decision of the committee in favour of electricity as a motive power for the lift at the Town Hall. He could, however, only say that it was a very strong committee, and that the general verdict was for electricity. He did not ask each member what was in his mind when he voted. Councillor Wilson questioned the correctness of the estimated cost of working the lift. From his experience of hydraulic lifts, and having regard to the statement by the surveyor that electricity would cost more, he suggested that £10 was a misprint for £100. Alderman Sendall said he and other members had hesitated in accepting the estimate, but they had before them in writing the statement of the surveyor; and Councillor Stafford assured the Council that the cost per journey would be only about a farthing, and that when the lift was not working the electricity could be switched off. Councillor Greenyer pointed out that a farthing a journey upon the basis of the committee's estimate would show a cost of over £50 a year. Councillor Wilson said he did not object to the proposal as to the lift; his object was merely to draw attention to what he believed to be a mistake in the estimate, and Councillors Baker, Berry, and Broadbridge having referred to the futility of debating the point when they were all agreed to have the lift, whether it cost £50 or only £10, the proceedings were agreed to.

Bangor (Wales).—At the monthly meeting of the Bangor City Council on Wednesday, the Mayor (Alderman Dr. R. Longford Jones) presiding, the Electric Lighting Committee reported that Mr. Meadows had presented his amended report and estimate as to the proposed electric lighting works, and that after considering the same the committee unanimously resolved that the Council be recommended to apply for a license, and that the committee be empowered to take whatever steps it may find necessary to carry out the scheme. On these minutes coming up for confirmation, Alderman Thomas Lewis, chairman of the committee, expressed himself unwilling to propose their confirmation. The further he looked into the matter the less inclined he felt to go on with the scheme. Dr. Grey Edwards thereupon moved the adoption of the minutes. The scheme, he said, had been most favourably reported upon, and enquiries made in other towns where the electric light was in use were equally favourable. They should not miss that opportunity of acquiring the necessary powers. Liverpool had missed its opportunity in this respect and a company had taken the matter up, with the result that Liverpool had now to pay through the nose for its remissness to the tune of something like £400,000. Councillor Robert Hughes, in seconding the motion, expressed great surprise at the defection of the chairman, who at the last meeting of the committee was quite enthusiastic in favour of the scheme. Dr. Rowland Jones felt convinced that it was inevitable that the town should be electrically lighted, and the only question was which scheme should be adopted. Alderman Thomas Lewis explained that further enquiries which he had made showed that no favourable reports had been received from such a small place as Bangor. They must also remember that another expert, Mr. Newbiggin, had said quite the opposite to Mr. Meadows as to electric lighting in small towns. Reference had been made to favourable replies to enquiries received from other towns where the electric light was in use. He would take the most roseate of these, the reply from Taunton. What did the figures show? Mr. Meadows had told the Bangor Council that in a year they would have 4,000 lights in use. But in Taunton, a place with double the population, and after four years' working, they had only 4,500 lights in use. Therefore, he (Alderman Thomas Lewis) could not see how they were going to get 4,000 lights going in Bangor in one year. He further found from the figures that the total receipts at Taunton were £2,079, and they had to pay in interest and dividend £420, and to the sinking fund £436. Such figures indicated an immense call on the rates of the town, even after four years' working. He moved, and Dr. Rowland Jones seconded, that the matter be referred back for further consideration. Dr. Grey Edwards, however, withdrew his motion, and moved the amendment, and the proposals of the committee were accordingly referred back.

Cheltenham.—A meeting of the Town Council was held on Tuesday, at which the Lighting Committee reported that since the last meeting the electric light cable had been laid from Cambray to the Belle Vue Hotel, and the borough engineer was daily expecting the delivery of the lengths for the Evesham-road; that an application had been received from Messrs. Webb Bros. for 2-b.h.p. motor at Alstone for chaff-cutting, etc., which would involve a length of 1,000ft. of supply from the Arle-road main, or if the new main is laid along Alstone Croft, of 350ft., and an increase of the length of the main of about 300ft.; that an application had been received from Mr. Henry Chapman for a supply to The Grove, Douro-road, which would involve an extension of about 250 yards; that an application had been received from Mr. W. B. Bingham for a supply to Rose Hill, which would involve an extension of the main in Evesham-road for a distance of about 800 yards, and that the cost of these extensions would be as follows: Messrs. Webb, Alstone, £35; Mr. Chapman, The Grove, £42; Mr. Bingham, Rose Hill, £130. It would be necessary, in view of the amount of energy applied for, to take into consideration the advisability of ordering an additional engine and alternator. It was resolved that the applications be acceded to, subject, as regards Messrs. Webb, to the minimum charge being £7 per annum, as regards Mr. Chapman to the minimum charge being £8 8s. per annum, and as regards Mr. Bingham's application, to the consent of the County Council being given to the laying down of the cable in the main road outside the parish. In view of the number of applications for supply of the electric light involving extension of the mains and provision of additional machinery, it was resolved to apply to the Local Government Board for sanction to borrow a further sum of £10,000. Mr. G. H. Williams, secretary to the Theatre Company, wrote with reference to the Streets Committee's promise to fix an additional lamp in Ormond-place and readjust the lamps in Regent-street, and the matter was adjourned pending the question of lighting the Promenade with electricity. A letter was read from Mr. C. H. Whitmore complaining that the wall of 48 St. George's-place had been injured during the construction of the electric light testing station. The town clerk's reply, stating that in the surveyor's opinion no damage was done by the builder, and that in any case the contractor and not the Corporation would be liable, was approved. Mr. Ticehurst, clerk to the Assessment Committee, wrote that he had advised his committee to assess the electric light works in the first instance at not less than £320 per annum, and to have as soon as possible a valuation by an expert. The town clerk's reply, informing him that as the matter then stood the Lighting Committee must appeal to the special sessions against the assessment, was approved. Alderman Norman proposed the adoption of these minutes, and this was agreed to.

Hampstead.—The Lighting Committee of the Vestry have recommended that two spare coils of each of the three sizes of armatures used on the alternators at the station be obtained at an estimated cost of £36; that a high-tension recording Thomson wattmeter, for checking the output of the station, be obtained at an estimated cost of £30; that an eight-day clock for the station be obtained at a cost of £2 5s; that a double set of indicators for the engines be obtained at a cost of £20; that covers for all the dynamos, to prevent breakdown by dust, be obtained at a cost of £9 9s.; that 2in. cast-iron pipes be laid from West End-lane to High-road, Kilburn, at a cost of £187; that the Vestry do approve of the order given by the engineer, as a matter of urgency, for two dozen house service boxes, at a cost of £91. 4s; that 500 yards of 19/17 house connecting cable be obtained at a cost of £79. 3s 4d.; that a small hand pump, to raise the water which accumulates in the coal-elevator, be obtained at a cost of £6. 10s.; and that the Vestry do approve of the order given by the engineer, as a matter of urgency, for certain small articles required in working the station, such as fire-bricks for boilers, worm and wheel for stokers, new valve for economiser, etc. The Vestry have adopted the report. The committee further reported at last week's meeting of the Vestry that they found that on June 22 11,000 8 c.p. lamps were connected to the Vestry's mains; that owing to the large extension now being made and to the applications from new customers it is calculated that at least 20,000 8-c.p. lamps will be connected to the mains by Christmas next; that the total capacity of the present plant at the station is 12,000 8-c.p. lamps; and they recommended that another plant similar to the large unit at present in the station, be ordered at once at the estimated cost of £2,325. Mr. Richardson called attention to the fact that Messrs. Siemens Bros. at first offered to supply this plant for £1,965, and suggested that the Vestry should

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go into the open market and buy what they required. In reply to the chairman, Mr. Cottam said that it would be wiser to have this supply from Messrs. Siemens, because, if anything should go wrong afterwards, it would be difficult to say where the fault lay if engines of different type were running side by side. Messrs. Siemens asked for an increased price because the Vestry had not, they said, adhered to the original contract, but had made purchases elsewhere. After some discussion the recommendation was referred back to the committee for further consideration, with power to act. A letter was received from the Board of Trade, forwarding copy memorandum of Major Cardew, R E., with reference to the application of the Vestry for the consent of the Board to the placing of four 25-kilowatt transformers in certain sub-stations erected in the parish. It was stated that in the circumstances they were unable to consent to the increased power, and special attention was called to the remarks as to the absence of proper ventilation in the chambers and as to the fuse boards and leads. This was referred to the Lighting Committee.

Limerick.—A meeting of the Corporation was held on Thursday last week, at which Mr. Bourke proposed that the necessary steps should be taken to put in force the provisional order obtained from the Board of Trade as to electric lighting. He said they might be a little behind other places—50 or 100 years—occasionally, but he should like very much that in regard to this question they should not be in the same position they were in with regard to the water and gas concerns, when they had to purchase the interests of rival establishments already in existence, and at very great expense. In both these cases—the water and gas concerns—the Corporation were the losers, because their forefathers had not sufficient enterprise to be the first in the field with reference to the introduction of those things into the city. In this case of the electric lighting of the city he hoped they would not allow the same thing to occur, but that the Corporation would take steps to retain for itself what it undoubtedly had a right to, the sole right, under the provisional order obtained from the Board of Trade, of supplying electric light to the citizens. The only thing that occurred to him to say was that Prof. Kennedy in his report over-estimated to a great extent the probable and immediate wants of Limerick in respect of electricity, and also over-estimated the probable consumption of electricity in Limerick for a good many years to come. Prof. Kennedy, he noticed, made comparisons with some English and Scotch towns of similar size, but which had undoubtedly more wealth, and where electric light was more used than it would be there He thought that they need not anticipate anything like the outlay mentioned by Prof. Kennedy—£18,000. Mr. Spillane mentioned that he could afford the Council very little information in addition to what was contained in Prof. Kennedy's report. The history of the project was familiar to the members. In 1892 their hands were forced to apply for a provisional order from the Board of Trade because two different companies served notice on the Corporation they were going to apply to the Board of Trade for powers to supply electricity to the city; and whether it was they were influenced by what took place with regard to the water and gas supplies, the Council so decided and got the provisional order. The expenses in connection therewith was £430, and the fee paid to Prof. Kennedy was 100 guineas, that being the outlay on the matter so far. The question now was whether they would stop or halt, which was the same thing, because, unless the Council proceeded in a very short time indeed, the Corporation might find the Board of Trade revoking their provisional order granted two years ago and grant a license to any company applying for it, no matter from what particular part of the globe that company might come. The time of the Corporation to give effect to the provisional order expired at the end of the year 1894, and they were on sufferance since, having now reached August 1, 1895. If any company applied to the Board of Trade, and undertook to supply the electricity, they would get a license, unless the Corporation took the matter up at once. He did not believe they would require £18,000, but that they could get the money as they wanted it from the Board, the power of getting the loan following on the granting of the provisional order. The gas concern cost £54,000, and of that sum £17 000 remained due. The total cost would be cleared off in 1899. Mr. Dundon, in answer to Mr. Clune, said he believed, as matters stood, the Board of Trade would grant a license to any of three companies now proposing to supply the city with electric light. He suggested a modification of the resolution, and it was agreed to. On the motion of Mr. Bourke, seconded by Mr. Gaffney, it was decided by 21 votes to 4 to call on the Local Government Board to hold an enquiry with a view to obtaining a loan for the purpose of introducing the electric lighting into the city in pursuance of the provisional order obtained by the Town Council.

Hastings.—A meeting of the Town Council was held on Friday last. The Roads Committee reported that they had received from the secretary of the Hastings and St. Leonards-on-Sea Electric Light Company, Limited, amended notice of the intention of the company (*a*) to carry a 7/20 concentric high-tension main from their works in Earl-street, up Priory-avenue to the junction of Stanley-road, crossing the railway bridge on the outside bottom edge of girder; (*b*) to construct an inspection-box on the upper side of the junction of Braybrooke-road with Priory-avenue, and another at the lower side of the junction of Stanley-road with Priory-avenue; (*c*) to carry low-tension cable from the first-mentioned inspection-box to the end of Stanley-road, and to construct a brick box at either end of Stanley-road aforesaid, to carry another low-tension cable from the said inspection-box northward, along the west side of Braybrooke-road (towards Park-road) to a brick box to be constructed at a point opposite No. 131, and to cross the road to that house; (*d*) to carry a low-tension main from the said inspection-box, across the road to 98, Braybrooke-road, and another piece of similar main from the same box, a distance of about 30 yards, southward, along the west side of Braybrooke-road (towards the railway station), such works to be carried out and constructed in manner specified in the notice, and in accordance with a plan submitted therewith. The committee recommended that such plan be approved subject to the respective works being carried out to the satisfaction of the borough engineer, and to the company giving the usual undertaking not to remove the covers of the boxes, except between the hours of 10 p.m. and 9 a.m., unless in case of actual emergency. The recommendation was passed. The Public Lighting Committee stated that they had been in communication with the Hastings and St. Leonards-on-Sea Electric Light Company, Limited, with a view to ascertaining the terms upon which the company would supply the two electric lamps proposed to be placed on the baths at White Rock, and had received a letter from the secretary to the company stating that his directors had carefully considered the matter, and found that £40 per lamp per annum was the amount they must ask. The committee had informed the company that they could not entertain the offer, and recommended that the proposal to erect electric lamps be abandoned. Alderman Tree said that as he brought the matter forward to the notice of the Council, he would like to propose, seeing the committee recommended that the proposal be abandoned, that the recommendation be adopted. He would have that entered on the minutes, but would further recommend that the question of lighting by other means be referred back to the committee, with instructions to make a further report. The price, £40 per year, was a most extravagant sum, and the electric light company had made a grand mistake in putting the price so high. He would never think of voting for such expense, and he thought some other means of lighting might be found for the south side of the baths, as it was urgently necessary. Councillor Chapman, as a member of the Lighting Committee, said the committee were of opinion that a light should be provided for that side of the baths, but none of them would ever think of paying the enormous price of £40 a lamp. He would second the proposal that the question of lighting be referred back to the committee. Councillor Burrell pointed out that the electric light company only charged £25 for the lamps now in use, and he could not see why an extra £15 each should be asked for two more of exactly similar kind. Councillor Tuppenny considered the reason the electric light company charged extra for these two was because they had lost money by the others, and it was their intention to recoup themselves out of those additional lights as far as possible There were differences of opinion as to the lamp which would be suitable for the purpose. The Mayor added his testimony to the fact that additional lighting was necessary at this point. The adoption of the report was put to the vote and carried.

West Riding Telephones.—The question of promoting a private service of telephones for the purposes of the West Riding constabulary has recently engaged the attention of the West Riding Standing Joint Sub-Committee. The committee have had two schemes before them. The larger scheme provides for the following divisional headquarters and sectional stations (county property) being connected with headquarters at Wakefield, the sectional stations being given in parenthesis: Wakefield (Normanton), Barnsley (Penistone), Rotherham (Rawmarsh), Doncaster (Mexborough), Pontefract (Castleford), Goole. Sheffield (Hillsborough), Tadcaster, Knaresborough (Ripon and Harrogate), Otley (Ilkley), Leeds, Keighley (Bingley), Bradford (Shipley, Pudsey, and Cleckheaton), Halifax (Brighouse and Elland), Saddleworth, Huddersfield (Holmfirth and Honley), Dewsbury (Batley, Heckmondwike, Morley, and Mirfield), and Todmorden (Hebden Bridge). The smaller scheme provides for the connection of the divisional headquarters named above only. Mr. W. E. L. Gaine, manager of the National Telephone Company, has written a letter to the sub-committee, in which he says: "Full detailed estimates of the two schemes submitted by Captain Russell have been got out and placed before me. The larger scheme will involve a capital outlay in material and labour alone, without any addition for engineering and administration, of £8,140, and the smaller scheme will, in like manner, involve a capital outlay of £6,080. The very lowest annual charge which the company can afford to make, if it is not to incur serious loss, is £1 436 (say, £1 400) on a 15 years' contract in respect of the larger scheme, and £1,059 (say, £1 000) on a like contract in respect of the smaller scheme. The larger scheme involves the erection and up-keep of 664 miles of wire, and the smaller of 492 miles. The figures are less than those given you previously, and are arrived at by extending the term of the contract from 10 to 15 years, and giving the county the full benefit of the lowest rate at which the company can borrow its money. They will leave the company without a shilling profit and with a possible loss. It must be borne in mind that the recent agreement which has been made between the Government and the company for the acquisition by the Government of the company's trunk lines has materially altered the situation, as out of 3,800 poles on the main roads, only about 1,700 are now the property of the company, the remainder having been acquired by the Government, and these latter will be taken over by the Government within the next few months and so soon as the arrangements can be carried out. Having regard to the fact that the company is affording to the county a large amount of exchange service, free of charge, in addition to paying the present way-leave charges in respect of the 1,700 poles remaining the property of the company, which makes the way-leave in respect of those poles a high one, it is only

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reasonable that the company should, in respect of the police contract, have a profit upon the transaction after the poles which have been acquired by the Government have been handed over; but, in view of the very strong representations you have made to me, and the desire of the company to maintain amicable relations with the county, and in full reliance that the county will render in the future every assistance it can to the company in the development and extension of the telephone service, I am prepared to advise the company to waive any question of profit, and to accept the contract at the figures I have named, for the full term. In view of the fact that the Government will, in the course of the next few months, take over the poles which they have acquired, it is essential that the wires for the police contract should be erected before the actual transfer, otherwise the company will be unable to carry out the contract without the consent of the Government, which, of course, may be refused. The company has a free hand until the transfer, but afterwards has no right to erect wires on the Government poles, though it has the right of having any existing wires maintained." The Standing Joint Sub-Committee recommend the adoption of the larger scheme, subject to satisfactory terms being arranged. It is suggested that the terms should include a condition that the wires and other erections, the cost of which is defrayed out of the sum of £8.140 referred to in Mr. Gaine's letter, should be the property of the County Council at the expiration of the lease and the sub-committee are of opinion that the rate of interest should be calculated at the rate of not more than 4 per cent. per annum.

PROVISIONAL PATENTS, 1895.

JULY 29.

14355. **A non-rotating terminal for wire or cable connections to electrical instruments and the like.** Charles Berry, 55, Fitzwilliam street, Huddersfield.

14360 **Improvements in bayonet-joint holders for incandescent electric lamps.** John Howard Pentland, Lis-na-Crun, Cowper-road, Rathmines co Dublin.

14393. **Improvements in voltaic batteries.** Desmond Gerald Fitz-Gerald, 53, Chancery-lane, London.

14403 **Improvements in or connected with electrical gas-igniting devices.** Jean Jahnsson, 45, Southampton-buildings, Chancery-lane, London.

JULY 30.

14446. **A combined astatic and dead-beat galvanometer especially for use on board ship.** Thomas Clark, 31, Southampton-buildings, Chancery-lane, London.

14473. **Improvements in and relating to electric clocks.** William Soule Scales, 45, Southampton buildings, Chancery-lane, London.

14476. **Improvements in transmitting and receiving attachments for telephones.** Horea Waite Libbey, 45, Southampton-buildings Chancery-lane, London.

14481. **An improvement in imitation candles for electric lights** Thomas George Poole and William Lowry, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14485. **Improvements in alternating-current arc lamps.** James Devonshire, 70, Chancery-lane, London. (Charles E Harthan United States.) (Complete specification.)

14486. **Improvements in four-motor reversing switches.** James Devonshire, 70, Chancery-lane, London. (Frank E. Case, United States.) (Complete specification.)

14492. **An improved arc regulator for electric lamps** Sinforoso Prieto, 18, Buckingham street, Strand, London. (Complete specification.)

14493. **Improvements in electromotors and dynamos.** Thomas Drake Hollick and Frederick William Hollick, 65, Chancery-lane, London.

AUGUST 1.

14577. **Improvements in multiple-circuit dynamo-electric machinery.** Charles Brooke Crawshaw and Rankin Kennedy, Hubert-street, Leeds road, Bradford.

14589. **Improvements in starting switches for electromotors and in apparatus therefor.** Charles Brooke Crawshaw and Rankin Kennedy, Hubert-street, Leeds-road, Bradford.

14615. **New or improved device applicable for use in connection with telephones.** Emma Delaney, 6, Lord-street, Liverpool.

14627. **Improvements in electric fire-alarms** Alfred Charles Brown and George Richard Neilson, 129, Algernon-road, Lewisham, London.

14638. **Improvements in electric brakes.** Joseph Crawhall Chapman, 70, Chancery-lane, London. (William B Potter, United States.) (Complete specification.)

14639. **Improvements in safety appliances for electric cars** Joseph Crawhall Chapman, 70, Chancery-lane, London. (William B. Potter, United States.) (Complete specification.)

AUGUST 2.

14676. **Improvements in shade holders for electrical and other lamps.** Hugo Hirst and William Everett Gibson, 73, St. Stephen's-road, Upton Park, London,

14709. **Improvements in electric arc lamps.** William James Davy, 40, Chancery-lane, London.

AUGUST 3.

14739. **Improvements in holders for incandescent electric lamps.** Jan Meines Huisman and Henry Charles Gover, 62, St Vincent-street, Glasgow.

14792. **Improvements in electric arc lamps.** The Rogers Arc Lamp Company, Limited, and James William Rogers, 24, Southampton-buildings, Chancery-lane, London. Complete specification.)

SPECIFICATIONS PUBLISHED.

1892.

7029 **Electric cables.** Hardingham. (Felten and Guilleaume.) (Second edition.)

1894.

11211. **Railway electrical signalling apparatus.** Grimes.
11320. **Telegraphic transmission.** Lake. (Pupin.)
13636 **Transmitting telegraphic messages, etc.** Whawell.
16542. **Search-light projectors.** Furneaux and Walker.
16918 **Electric conductors.** Fox.
17357. **Arc lamps.** Allin and Wood.
17369 **Secondary voltaic batteries.** Epstein.
17566. **Electrodes.** Schäfer and Heinemann.
25215 **Electrically-propelled vehicles.** Baker and others.

1895.

7548. **Controlling electric currents** Siemens Bros. and Co. Limited. (Siemens and Halske.)
9704. **Electric rail or tram switches.** Porter.
10836. **Storage batteries.** Payen.
10929. **Electrolysing chloride solutions.** Hermite and others.
11283. **Electric fuse heads.** Pettinger.
11375. **Covering for electric wires.** Randall and Shallcross.
11399 **Arc lamp.** Parmly.
11478. **Electrolytical separation of precious metals.** Johnson. (Pelatan and another.)
11540. **Electric primer.** Morris Tube Ammunition and Safety Range Company, Limited, and Wyatt.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5⅝
Brush Company, Ordinary	3	2-2½
—— Nom. Cum., 6 per cent. Pref.	2	2¼-2⅝
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5½-5⅝
Chatham and Rochester	—	—
Chelsea Electricity Company	—	—
City of London, Ordinary	10	14½-15
—— 6 per cent. Cumulative Pref.	10	15½-16½ xd
—— 5 per cent. Debenture Stock	100	131-134
City and South London Railway, Consolidated Ordinary	100	41-43
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14½-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1-2
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A 1-200 of £50	100	—
Electric Construction, Limited	2	¾-1
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	1-2
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	¾-1⅛
Elmore's Wire Company	2	¾-1⅛
Fowler-Waring Cables	5	2-3
W. T. Henley's Telegraph Works, Ordinary	10	10½-11½ xd
—— 7 per cent. Preference	10	15-15½
—— 4½ per cent. Debentures	100	104-107
House-to-House Company, Ordinary	5	3¾-4
—— 7 per cent. Preference	5	7⅛-7½
India Rubber and Gutta Percha Works	10	19-21
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅛-7½
—— Pref.	—	—
Liverpool Overhead Railway	10	10⅜-10½
—— 5 per cent. Pref.	10	15½-15¾
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	¼-½
Metropolitan Electric Supply	10	10¾-11½
—— 4½ per cent. First Mortgage Debenture Stock	100	116-119
National Telephone, Ordinary	5	6½-6⅝
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-107
Notting Hill Company	10	8½-9
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	5	7½-7¾
—— £4½ shares	4½	6-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8-8½ xd
—— 7 per cent. Pref.	5	9-9½ xd
Swan United Ordinary	3	2-2½
—— 4½ per cent. Debentures	100	104-107
Telegraph Construction and Maintenance	12	43-45 xd
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4⅜-4⅝
Westminster Electric Supply, Ordinary	5	7⅞-8½ xd
Yorkshire House-to-House	5	5½-6⅛

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NOTES.

Mining Institute of Scotland.—A meeting of this institute was held in the hall of the Royal Scottish Society of Arts, George-street, Edinburgh, on Saturday. Mr. Mitchell, president, occupied the chair and read a paper on "Electric Coal-Cutting at Glencleland Colliery."

The Pacific Cable Project.—A Reuter's telegram from Victoria (British Columbia) reports that it is stated here that Mr. F. W. Mackay, the Canadian Pacific Railway, and a number of San Francisco capitalists are co-operating with a view to securing the contract for laying the projected Pacific cable.

The British Association.—Notwithstanding the pressure of his official duties, Lord Salisbury will visit Ipswich on the occasion of the meeting of the British Association, and will, in his capacity as retiring president, preside at the inaugural meeting at the Public Hall on Wednesday, September 11.

The Invention of the Electric Telegraph.—The Queen has accepted a copy of "Extracts from the Private Letters of the late Sir W. T. Cook, relating to the Invention and Development of the Electric Telegraph," which has recently been published by permission of the Institution of Electrical Engineers.

German Electric Lighthouses.—A Bremerhaven correspondent says that the lighthouse at Wangeroog is to be fitted with the electric light, and that the light of the pharos on the Rothensand at the mouth of the Weser is to be converted into an electrical one, the current for which will be conveyed by a submarine cable.

The First Use of Platinum.—It is recorded that the first Ural miners were much disgusted with platinum, and did not know what to do with the hard, dirty-looking metal. They thought that they had solved the problem of successful utilisation when they made bullets of it for their sporting muskets. The annual platinum consumption of a few years ago of four tons has, of course, increased very considerably with the development of electric lighting.

Electric Light in the Suez Canal.—Consul Gould, of Port Said, reports to the Foreign Office that the percentage of ships using the electric light to pass through the canal have been as follows: 1890, 83 per cent.; 1891, 88 per cent.; 1892, 90 per cent.; 1893, 92 per cent.; and 1894, 94 per cent. The average time in passing through the canal was in 1894: with the electric light, 19 hours 18 minutes; without the electric light, 31 hours 17 minutes.

The Telautograph.—The *Times-Herald*, of Chicago, has been the first newspaper to use the telautograph in furnishing Press despatches. That paper recently published photographic facsimiles of a number of messages in the identical handwriting of the author sent to it the previous night from prominent men who were in attendance at the League Convention in Cleveland. The instrument worked successfully over a circuit 430 miles long. The longest trial heretofore given the telautograph was between Paris and London.

The Proposed Jungfrau Railway.—The trigonometrical and photogrammetrical surveys for the construction of the proposed railway up the Jungfrau are to be completed as far as the Eiger station before next winter, and the construction of the section between Scheidegg and the Eiger glacier is to be commenced next spring. Tenders will be invited for the laying of the permanent way and for the construction of the stations and other surface works, as well as for the supply of the necessary rolling-stock and electrical appliances.

The Electricity!—Albert Greenshields, a tailor's cutter, was charged on Monday at Marlborough-street Police Court with being drunk and disorderly. The police found the accused drunk in Oxford-street on Saturday night. Instead of going away he laid down in the road. The prisoner: I fell down; I was tipsy at the time. Mr. Hannay: You must have been very far gone to fall down in the road. The prisoner: It was the electricity in the weather. I took a little drop of whisky to stop a feeling of sickness. Result, 10s. or seven days.

Electrical Communication with Lighthouses.—The members of the Royal Commission on Electrical Communication to Lighthouses and Lightships started on a tour of inspection to Denmark and the Baltic on Tuesday, the 13th instant. All the principal Danish lightships and lighthouses, both in the Baltic and North Seas, will be visited. The Post Office authorities have placed their cable ship "The Monarch" at the disposal of the Commission for this tour. The Commission expect to return to England about Friday, the 23rd instant

Electric Dispersion.—Herr P. Drude, in *Wiedemann's Annalen*, describes a method of investigating the relation between the dielectric constant of a substance and the period of the electric waves traversing it, or what may be described as the electric dispersion of the substance. If the dielectric constant decreases as the period increases, there will be normal, if it increases, anomalous dispersion. For alcohol dispersion was found to be normal, and of the same order of magnitude as its optical dispersion. Water showed abnormal dispersion with the large wave-lengths used, whereas ebonite showed no perceptible dispersion.

Electricity in Russia.—Our Russian contemporary, *Elektritchestvo*, announces that a special electrical department is about to be added to the Railway Ministry. The same journal gives a somewhat belated account of the Marien Palace electrical installation in St. Petersburg, which was inaugurated in 1893. There are 1,500 lamps. The plant was German. It is, moreover, announced that the municipal authorities of Kiev have concluded a contract with the Allgemeine Elektrizitäts-Gesellschaft for the establishment of electric light in the ancient city at a cost of one million roubles (£150,000), part of which sum the German company will take in corporation stock.

New Electrical Journals.—The latest electrical periodical to make its bow to a wondering world is entitled *Electrochimie*, and it is edited by M. Adolphe Minet, formerly manager of the aluminium works at Saint-Michel-de-Maurienne. Its programme is to comprise natural forces, electrometallurgy, industrial chemistry, applications of electricity, mechanical construction, and aluminium and its alloys. Of a slightly different character is the *Electrical Worker*, the organ of the National Brotherhood of Electrical Workers of America, which is published in St. Louis, and which is described as "devoting considersiderable space to practical matters, in addition to society gossip."

A New Tramcar Motor.—According to the *Glasgow Herald*, Mr. G. Johnston, a Glasgow engineer, has invented a new motor, which he has been running on an experimental car on the Glasgow tramways. Our contemporary lucidly explains the motor as follows: "So far as we can ascertain, the power in use is a combination of steam and electricity; but neither smoke nor steam is visible, and the car glides noiselessly along the street. The motor is contained in a box about 3ft. in height and 2ft. in diameter, and is placed on the front platform of the car immediately behind the driver." Persons managing to get an idea of what the motor is from this description deserve to be awarded a gold medal.

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One Hundred and Fifty Miles an Hour by Electricity.—A *Standard* New York telegram says: "The Baldwin Locomotive Works and the Westinghouse Electric Company are such substantial concerns that the working alliance between them, which has been announced, possesses considerable industrial importance, apart from certain plans which, if realised, would revolutionise transport service. Practical men believe that the Tesla electric motor will enable any speed to be obtained that the cars and the track can endure. The promoters of this scheme contemplate perfectly level straight tracks, crossing mountains by lifts and valleys by trestles, using cars much lighter than the present ones, and each by means of its own motor travelling at a rate of 150 miles per hour."

Electrical Resonance.—According to the *Annalen der Physik und Chemie*, Mr. V. Bjerknes has collected in a long and exhaustive paper the results of his experimental and mathematical study of this subject, and he shows that for quantitative measurements of electric waves great regard must be paid to the following five conditions: (1) the time of vibration of the oscillator; (2) the time of vibration of the resonator; (3) the logarithmic decrement of the oscillator; (4) the logarithmic decrement of the resonator; (5) the constant which measures the intensity of the vibrations. He shows that resonance phenomena are in general only suitable for quantitative measures when the mean value of the logarithmic decrement of the two conductors is smaller than 1. He indicates that quantitative measures with a spark micrometer are subject to error, and that the electrometer method used by him is more suitable for the determination of the above five conditions.

Last Year's British Patents.—The twelfth report of the Comptroller-General of Patents states that, though the number of applications for patents in the year 1894 continued upon an ascending scale (being 270 more than in the previous year), this increase was considerably less than that of the normal average of the preceding seven years. The number of applications for patents has increased from 17,176 in the year 1886 to 25,386 in 1894; being at the rate of 48 per cent. It is interesting to notice a large increase in the number of applications for patents from Ireland last year as well as in 1893; while among the colonies, the largest proportionate advance is shown by Queensland. As respects similar applications from foreign States, Belgium, Germany, and Sweden had the largest increase; the number of applications from France having remained curiously stationary during the past 10 years—being 788 in 1884, and only 799 last year. The applications from the United States, which reached the number of 2,597 in 1890, have fallen off since that date, and amounted to only 2,017 in 1894.

Prof. W. R. Smith on Electric Lighting.—In the course of a speech which he delivered at the recent congress at Hull of the British Institute of Public Health, Prof. W. R. Smith, medical officer of the London School Board, and president of the institute, said that he would like to say a word in connection with a department of public health which he saw had been carried out in Hull with very important results, and from a ratepayer's point of view with the most important result of a balance to the good—he meant the electric lighting. He thought that the question of electric lighting, which they all recognised as the proper lighting for the future, and the development of which no one in that room could properly realise, was a most important one for everybody entrusted with the public health and the social advancement of their respective districts. He sincerely congratulated the Electric Lighting Committee and its able chairman, Councillor Holder, and the Corporation of Hull, upon the very successful results that had attended the experiments of the introduction of that modern development of lighting.

Economic Power Production.—A daily paper states that the supremacy of the steam-engine is threatened not only by electricity but also by gas-engines as a cheap source of motive power so essential for industrial development. Gas-engines have been brought by engineering skill to a high state of efficiency, but a great drawback, when compared with the steam-engine, has been that the gas-engine could not use ordinary steam coal and inferior fuels. It is now claimed, however, that this obstacle to the more extended use of gas-engines has been removed, and that by the invention of Mr. Thwaite, C.E., the gas-engine can compete with, and in economy of fuel surpass, the steam-engine on its own ground and with its own fuel or bituminous steam coal. Such a gas-engine is shown at work at Stoke Newington driving an electric equipment, and it is stated that peat, refuse slack coal, and ordinary steam coal have been successfully used, and this without the use of any steam boiler, thus removing a dangerous auxiliary to steam-engines, and with it the smoke nuisance and the difficulties of hard and impure water.

The Argentine Cable Question.—A meeting of the Balloon Society was held on Tuesday night, when a paper was read by Señor Juan Sauchez-Villeyas on "Gleanings from the History of Brazil and Trinidad." The author, with regard to Trinidad, stated that it was advisable for England to retain the island, to facilitate the laying down of a cable from Europe to Argentina and other South American States independent of Brazil. Mr. E. S. Roberts moved, "That, having regard to the unique and influential position of Great Britain in promoting the progress of humanity throughout the world, and the high character of the statesmanship by which her world-wide affairs were directed, it is desirable, in the interests of the nations at large, that she should retain possession of the island of Trinidad, as well as other convenient stations, which are necessary and contributory to the fulfilment of her high mission, and when it is considered that Great Britain owns seven-eighths of the submarine cables of the world, and that she has invested capital therein to the amount of £3,000,000, the commanding importance of the matter as a practical necessity cannot be exaggerated." The motion was adopted.

Horseless Carriage Contest.—A horseless carriage race between Chicago and Milwaukee, promoted by the *Times-Herald* of Chicago, will be decided on Saturday, November 2, the object being to encourage and stimulate the invention, development, perfection, and general adoption of motor carriages. The amount offered in prizes is 5,000dol., apportioned as follows: First prize.—2,000dol. and a gold medal, open to competition to the world. Second prize.—1,500dol., with a stipulation that, in the event of the first prize being awarded to a vehicle of foreign invention or manufacture, this prize shall go to the most successfully American competitor. Third prize.—1,000dol. Four prize.—500dol. The third and fourth prizes are open to all competitors, foreign and American. The rules laid down stipulate, among other things, that no vehicle shall be admitted to competition which depends in any way upon muscular exertion, except for purposes of guidance. Competing vehicles which derive their power from petroleum, gasoline, electricity, or steam, and which are provided with receptacles for storing or holding the same, will be permitted to replenish the same at Waukegan, Ill., and at Kenosha, Wis., but at no other points.

Association of Municipal and County Engineers. A meeting of the association will be held at Londonderry on the 23rd and 24th inst. The programme is as follows;

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on Friday, 23rd, the members will meet in the Town Hall, Londonderry; 11.30, district business; 12, reception by the Mayor. Papers will be read on the "Electric Lighting of Londonderry," by Mr. J. Christie, city electrical engineer, and on "Municipal Electricity," by Mr. James Perry, M.I.C.E., county surveyor, Galway. After luncheon visits will be paid to the electric light station, filter beds, city walls, etc. On the 24th the members will meet at the Town Hall, Portrush, at 9.30, when papers will be read on "Fire Brigade Work," by Mr. J. Munce, A.M.I.C.E., chief assistant surveyor, Belfast Corporation, and on "Light Railways and Tramways," by Mr. R. H. Dorman, M.I.C.E., county surveyor, Armagh. The members will then leave Portrush by special electric cars, stopping at Bushmills, and visit the electric power generating station, arriving at Causeway at 1.15. Special cars will leave the Causeway at 5.45, stopping at Dunluce Castle. Mr. W. A. Traill, C.E., managing director and engineer of the electric tramway, will join the party and describe the working of the line.

The Smell of Lightning.—In connection with the thunderstorm of last Saturday evening, Sir H. W. Tyler has written to the *Times* as follows: "One of my daughters, as we were watching the storm, opened a glass door leading southward into the garden (at Pymmes-park, Edmonton), and at that instant we all appeared to be enveloped in a brilliant atmosphere of blue light, with simultaneous thunder. When the lightning disappeared and the thunder ceased we all exclaimed, 'What a smell of ozone.' This was unmistakable. We were all perfectly familiar with it, as being what we had so often experienced in the use of the Wimshurst electric influence machine and other ozone-producing agencies. It would be most interesting to know whether others have noticed similar lightning phenomena." In response to this, Mr. G. J. Symons, F.R.S., writes: "I have never personally been near enough to a flash of lightning to smell it, but Sir Henry Tyler is perfectly correct in his identification of it with ozone. The ordinary Briton does not know the smell of ozone, and therefore when a flash of lightning comes unpleasantly near he always describes it as 'brimstone' or 'sulphur.' I have scores of records of that kind, but the actual identification by Sir Henry Tyler is, I think, new. Experts know perfectly well that the odour described as 'sulphurous' was that of ozone, but I do not remember hearing of any one who actually smelt and identified it."

Institution of Junior Engineers.—The annual summer meeting of this Institution, whose headquarters are in London, takes place from 17th to 24th inst., the rendezvous being Belgium. The towns to be visited include Antwerp, where the municipal docks, M. Kryn's diamond-cutting works, and other places of interest will be opened to the member's inspection. At Ghent MM. Carel's Engine Works, M. de Hamptinne's Cotton Spinning Works, and M. Van Houtte's Nursery Gardens will be seen; at Brussels, the electric lighting station; whilst at Liége the works of the Société Cockerill, the Vieille Montagne Zinc Works, the St. Leonard Locomotive Works, the Val St. Lambert Glass Works, the Small Arms Factory, and the electric tramway installation, will be visited. In honour of the institution a banquet is to be given by the Liége section of the Society of Engineers from the university, and the members will also be the guests of the Société Cockerill. An excursion to Verviers, where the Chamber of Commerce will entertain the visitors, is arranged for the purpose of seeing works in connection with the woollen cloth industry. Here M. M. Peltzer's Works and those of M. Duesberg-Delrez, La Vesdre, and M. Hauzeur Gerard Fils, will be opened. The celebrated Gileppe reservoir, from which Verviers receives its domestic and manufacturing supply, is also included in the programme. A large number of members have notified their intention of being present at the meeting, which promises to be one of the most successful the institution has held.

Magnetic Rotation of Solutions of Hydrogen Chloride.—Mr. Otto Schönrock, in *Zeit. Physikal. Chem.*, states that the magnetic rotation of hydrogen chloride in aqueous solution, according to the observations of Perkin, is double that of its solution in isoamylic ether, and the cause has been ascribed to the electrolytic dissociation in the former solvent. The author had previously found an equal rotation in the two solvents and has therefore carefully repeated and extended his researches. Solutions of the gas in water, isoamylic ether, isoamylic alcohol, ethylic alcohol, and in mixtures of these compounds were examined. The rotations of the solvents were first obtained and then those of the solution, 25 liquids being so treated. The rotation is taken from the mean of four or five separate results, and is given in thousandths of a minute. This is an unnecessary refinement, however, as the separate results under similar conditions differ in many cases by nearly a minute. The results may be summarised by a table; values due to Perkin being added and marked*; the first column for each solvent giving concentration, the second the molecular rotation.

Water.		Amylic ether.		Amylic alcohol.		Ethylic alcohol.	
11·45	4·774	0·76	4·036	1·58	5·413	6·59	4·491
25·06	4·404	2·34	2·838	6·89	4·028	9·78	4·201
*15·63	4·419	3·45	3·322	9·49	3·809	14·64	4·232
*25·60	4·405	8·96	2·101	*25·45	3·285	*40·04	3·365

The rotation decreases with increasing concentration, not only in aqueous solutions but in those of other solvents, hence the author considers that dissociation has no effect on the magnetic rotation of solutions.

Therapeutics of High-Frequency Currents.—The paper read by Dr. Apostoli on this subject at the meeting of the British Medical Association is an important one, the *Lancet* says, and represents the direct practical application of the physiological facts brought about by D'Arsonval's experiments with animals. The current of high frequency and high potential is caused to traverse a large helix inside which the patient is placed, and the effect is to set up induction currents of a similar kind inside the patient's body. These travel in closed circuits through the tissues and produce nutritive changes, which can be recognised by their effect in increasing the elimination of carbon dioxide and of urea. The actual figures are promised at an early date. The results are good in diseases characterised by failure or impairment of nutrition, and accordingly Dr. Apostoli reports successes in anæmia and debility, gout, rhematism, neurasthenia, and hysteria. In diabetes, also, there have been some favourable cases. The principle of the localised application of electricity for the relief of disease, so ably insisted upon by Duchenne, has delayed the recognition of the important general effects to be obtained from electrical treatment. At present there is a distinct movement in favour of general electrification as a therapeutic means, and the results appear to be almost identical in character, whether the method employed be by the alternate-current electric bath, advocated by Gautier and Laret, or the high-potential induction method of D'Arsonval and Apostoli, or the electrostatic methods favoured by Vigouroux and Morton, of New York, who use the Wimshurst or some similar machine as the source of the electricity applied.

Carriage of Mails.—A Chicago paper writes as follows: "Should the City Council grant Richard E. Sherman permission and authority to construct and operate

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underground electrical mail tubes, Chicago will have the finest mail distributing system in the world. Think of mails coursing through subterranean passageways at the rate of a mile a minute. Yet this is what Postmaster Hesing, Superintendent John A. Montgomery, and electrician Richard E. Sherman declare to be a demonstrated reality. Last fall the Superintendent of Mails made a trip to Philadelphia to investigate the pneumatic tube mail service in that City. Upon his return he said to electrician Sherman: 'Sherman, why can't you invent an underground apparatus which will carry all our mails? May be you don't know it, but we handle from 275 to 300 tons of mails a day. Why not get up an underground electrical-car system by which all this stuff can be transmitted from the sub-stations to the central office and thence to the depôts?' That was enough. Sherman caught the idea, returned to his laboratory, and soon perfected the system. The details were forwarded to Washington, and a patent secured June 27. Alderman Coughlin introduced an ordinance on Monday night in the City Council granting to Sherman authority to operate electrical tubes and electrical conduits for the purpose of transmitting mail packages and all other suitable commodities. The company is to pay into the city treasury 30 per cent. per annum of the gross receipts." It is difficult to find anything remarkable in this scheme. "Think of mails coursing through subterranean passageways at the rate of a mile a minute," says the Chicago paper. We have thought of it, and fail to see anything wonderful in the speed at all.

Crystal Palace School of Engineering.—The certificates awarded for the summer term at the Crystal Palace School of Practical Engineering were distributed on Friday last by Sir Robert Rawlinson, past-president of the Institution of Civil Engineers. The ceremony, which was largely attended, took place in the examination hall, situated at the base of the North Tower, where the work of the school is carried on. The reports of the examiners were read by Mr. R. G. Hodson, superintendent of the Crystal Palace School of Art, Science, and Literature. Mr. D. Allport, jun., A.M.I.C.E., who had examined the work done by the students in the mechanical section, drawing, pattern-making, and fitting, expressed himself as much pleased with the variety and thoroughness of the training. Similar satisfactory reports were made by Mr. C. S. Meik, M.I.C.E., and Mr. G. W. Aldridge, A.M.I.C.E., concerning the work in the civil engineering and electrical sections of the school, but at the same time Mr. Aldridge remarked that it was a matter for regret that so few students took advantage of the electrical department. Before distributing the awards, Sir Robert Rawlinson delivered an address to the students. After speaking very highly of the valuable training given at the school, he referred to theories as to the formation of the earth. He himself had come to the conclusion that the earth was not solid, but that it was a shell having a crust of a given thickness—in fact, a soap bubble would represent a miniature world. The earth contracted and expanded, and had no permanent stability. The certificates were afterwards distributed, among the most successful students being Messrs. W. T. Harbord, T. W. Simpson, M. A. Harenty, F. G. Brooker, E. Byron, L. N. Heberden, H. E. Kent, R. T. Burrows, L. de Ridder, J. G. McG. Pearce, and W. Riddell.

The Malignani Exhaustion Process.—Signor Arturo Malignani, the well-known electrician of Udine, has (*L'Elettricità* of August 11 says) devised a new method of producing the vacuum in incandescent lamp globes, a method which obtained a gold medal at the recent Scientific and Industrial Congress at Venice, and which has been patented in all countries. Signor Malignani commences by introducing into the evacuation tube a small portion of a special chemical composition. The lamp is fixed to the pump, and after about 20 seconds current is passed through the filament. At the expiry of 10 or 15 seconds of illumination the tube is closed, cutting off communication with the pump. When this is done the lamp is relighted, and the glass tube is heated with a gas jet at the point where the special material is situated which was inserted. This heating produces vapours which with the co-operation of the electricity have the effect of causing the vapours emanating from the filament to be precipitated into the solid state, producing a perfect vacuum in the globe. The whole operation lasts about a minute. Forty-five or more lamps can, it is affirmed, be exhausted in an hour. The great advantage claimed for the process is the avoidance of mercury. The pump is in three parts, the third portion communicating with the lamp. The filaments of the Malignani lamps are prepared as follows: about 30 sheets of white paper are placed one above the other, each of them being washed with acidified water. The pack of paper is heated to 70-80deg., which transforms it into a transparent gelatinous mass. When the paste is cooled it is subjected to great pressure and forced out of a pipe, whence it falls into a mixture of water and nitric acid; then it is washed, dried, and carbonised. Signor Malignani's establishment has, it seems, been visited by various electrical engineers of note, including Mr. Swan and Mr. Stearn; and various lamp-making firms are, it is stated, negotiating with the inventor for the right to utilise his device.

Ananias At It Again.—The following gem is from an American lay paper, but it is quoted without comment in the *Scientific American*, though one wonders "*que diable allait il faire dans cette galère.*" It serves to show that the American Press has not lost its talent for telling lies. "A lamp that will burn for 600 hours is the invention of George L. Roberts, an electrician, who sold to a tobacco company, for 80,000dol., the advertising rights of some of his electrical devices. The lamp of which Mr. Roberts is the inventor is charged with sand, into which two wires are run, which connect with one of the regulation bulbs used on all electric chandeliers. The battery is therefore the sand, but the method of charging it remains a secret with Mr. Roberts. Mr. Edison, after seeing Mr. Roberts's lamp, remarked that he thought he knew all there was to know about electricity, but Mr. Roberts had made a discovery which puzzled him greatly. Mr. Roberts presented Mr. Edison with some of this remarkable sand, but with no fear of having his secret discovered, for analysis happens in this case to kill all traces of the secret discovery. The cost of recharging each lamp is 17 cents. A friend of mine who has a contract with Mr. Roberts, having bought from him the rights of one of his inventions, tells me he would not have believed the tale of the lamp had he not seen Mr. Roberts throw a handful of sand into an ordinary tumbler, inserting two wires into the sand, and connecting the wires with an ordinary electric burner, which burned brilliantly. Mr. Roberts made his discovery in Minneapolis, in a purely accidental way. He was experimenting with acids in his laboratory and on the table was some sand, over which two wires had fallen and crossed themselves. By an accident a bottle containing a certain acid was overturned and some of the acid ran into the sand at the point where the wires crossed. The result was a series of electric sparks. At present Mr. Roberts is quite a sick man, and is in Michigan for his health. Another of his inventions is to make 72 changes of colour

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in the hair, dress, tights, shoes, and so forth, of a dancer while she is in motion. The mechanism works by clockwork, and the light gleams through the fabrics from a direct current. Mr. Roberts married a daughter of Pillsbury, the great Minneapolis miller."

Experiment on Thermo-Electric Currents.—The classical experiment by means of which are rendered evident the currents that traverse a circuit formed of two metals when the solderings are at various temperatures becomes, says *La Nature*, more striking when, instead of mounting a magnetised needle upon a pivot placed in a fixed circuit, the circuit is, on the contrary, rendered movable, the magnetic field being in an invariable position. The idea of this reversal of the experiment is far from being new, since it is upon this principle that is based the radiometer devised by Dr. D'Arsonval, and greatly improved in its construction by Mr. C. V. Boys. This radiometer is a very delicate instrument of measurement which requires exceeding care and great manual skill for its construction; but the apparatus that we are going to describe operates perfectly as a demonstration instrument, without the necessity of much attention being bestowed upon it. It consists of a simple wheel placed in equilibrium upon a needle, and which the thermo-electric currents set in motion under the action of a magnetic field. This wheel is constructed with the greatest ease by bending into a circle a fine wire of an alloy of nickel and copper, found in the market under the name of white bronze or superior German silver. This alloy, when soldered to copper, has the property of giving considerable thermo-electric E.M.F., much less, doubtless, than that of bismuth or antimony, but it has the advantage of possessing a high point of fusion in addition to that of being able to be drawn out into fine wire—a condition essential for the good operating of the apparatus, the solderings of which become heated or cooled instantaneously. The rim of the wheel having been closed by solder, there is fixed upon it a certain number of diameters of very fine copper wire insulated from each other, and which are soldered after their extremity has been wound around the German-silver wire. One of these diameters receives in its centre a small disc of metal in which a slight depression has been formed. The wheel having been placed upon a needle, through the intermedium of this depression, is regulated by means of little banners suspended from some of the radii, and which, while lowering the centre of gravity of the wheel, permit of displacing it at will and rendering it horizontal. Let us suppose, now, that we heat one of the solderings by means of a candle. A difference of potential will establish itself between the opposite solderings, and an electric current, traversing the diameter that ends at the soldering, will return, in bifurcating itself, through the rim. If we place a horseshoe magnet in such a manner that it shall embrace a portion of the diameter, in the half opposite the hot soldering, the magnetic field will act upon the radius at right angles with its direction. Since, however, the action upon the rim is exerted in the direction of the radius, it would be null even were the bifurcation unequal, and the wheel will begin to revolve under the action of the couple produced. The revolution, which is slow when somewhat coarse wire is used, becomes very rapid, on the contrary, with fine wire, which, consequently, should be selected by preference in order to render the experiment as striking as possible. Wire of from one-tenth to two-tenths of a millimetre is perfectly adapted for a wheel of from eight to ten centimetres diameter. This transformation of calorific into electric and mechanical energy is the simplest that can be imagined.

Super-Sulphates and the Accumulator Theory of Darrieus.—This formed the subject of a paper which was read by Dr. Elbs at the recent annual meeting of the Deutsche Elektrochemische Gesellschaft at Frankfort-on-Main. The production of super-sulphates is, it is known, attended with difficulties. Dr. Elbs, of Frankfort, now claims to have devised a simple process by which these difficulties are removed. He has constructed an apparatus containing a platinum wire anode, the cathode being placed in a capillary above the anode in order to prevent the reduction of the super-sulphuric acid formed. An additional glass tube is fixed over the anode to allow the gases to escape. The electrolyte consists of sulphate impregnated with sulphuric acid. Soon after the current is applied the super-sulphates are detached in crystalline form. The solution, of course, retains a certain quantity of them. When heated with hydrochloric acid, chlorine is developed. Heating by itself evolves free oxygen. Herr Darrieus has given out a new theory, according to which the action in an accumulator proceeds from the presence of free super-sulphuric acid. Schoop declared himself to be of this opinion in the *Z. f. Elektrot. u. Elektrochemie*, 1894, Heft 9. On charging the accumulator super-sulphuric acid occurs at the one electrode, which converts the lead oxide and any lead sulphate into lead superoxide. As soon as this takes place, the resulting super-sulphuric acid decompounds into ordinary sulphuric acid and oxygen, which escape as gas, indicating that the charging of the superoxide electrode is completed. At the negative plate a reduction of the lead sulphate to spongy lead takes place, and when this is done occlusion of small quantities of hydrogen through the spongy lead occurs. Finally, the hydrogen appears as free gas, showing that the charging is concluded. When discharging, the occluded hydrogen is first oxidised to water, and the super-sulphuric acid present is reduced to ordinary sulphuric acid. The primarily increased E.M.F. of the accumulator corresponds to this procedure. Thereafter the oxidation of a part of the spongy lead on the negative plate into lead suboxide is completed, the suboxide at the same time being decomposed by the electrolyte into metallic lead and lead sulphate. On the positive plate lead superoxide is transformed into lower degrees of oxidation, which, with sulphuric acid, in course of time are partially changed into lead sulphate. This latter sulphatisation is the product of the combination PbO_2, PbO, H_2SO_4, and results, as is known, in the spontaneous discharge of the positive plate. This only ceases when there is no more lead superoxide present, and explains why superoxide electrodes can be completely transformed into lead sulphate. Because, Dr. Elbs states, Herr Darrieus examined in detail the causes of the gradual decomposition of the superoxide electrodes, he came to the above-named conclusions. Dr. Elbs argues, however, that this is not the case, and he points to the following experiment: If to super-sulphate of ammonium be added a lead salt—say acetate of lead—upon heating, lead sulphate together with lead superoxide is evolved. This reaction does not, however, take place in acid solution. It must rather be neutral or weakly alkaline. Now, free sulphuric acid is in the accumulators. The lead superoxide cannot therefore owe its inception to the super-sulphuric acid. A further experiment with super-sulphuric acid may be mentioned. If the solution of ammonium persulphate be combined with a lead salt and filtered from the precipitate, super-sulphate of lead is found in solution, which, upon heating, decomposes, lead superoxide being formed. These experiments, Dr. Elbs says, show that the super-sulphuric acid has nothing to do with the action of the accumulator.

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THE ANNUAL MEETING OF THE VERBAND DEUTSCHER ELEKTROTECHNIKER AT MUNICH.

(BY OUR SPECIAL CORRESPONDENT.)

(Continued from page 91.)

INTERVIEW WITH MR. C. E. L. BROWN.

In my quest for original information on the methods and successes of electrical engineers in Switzerland, I reached Baden and wended my way to the works of Messrs. Brown, Boveri, and Co. The commissionaire at the entrance informed me as he conducted me to the waiting-room that Mr. Brown was in, and I received a very cordial welcome from that gentleman, who wished to show me over his works at once, but I persuaded him to answer a few queries first. I tackled him on the alternating-current motor question.

C. E. L. BROWN.

"You, Mr. Brown," I said, "have had more to do with the construction of alternating-current motors than any engineer in Europe, and I should like to know by what processes you have reached your present stage of perfection."

"I commenced," he replied, "in 1890, a year before the opening of the Frankfort Exhibition, and then built simultaneously a two-phase and a three-phase motor for experimental purposes. It was stated that the three-phase motor only would be successful, but I found that the two gave equally good results as regards output, power, and efficiency. In fact, even now we use exactly the same patterns for two-phase and three-phase machines of the same output, and only vary the winding arrangements."

"What was the next step in your investigations, Mr. Brown?"

"I found accidentally that the multiphase motor, if started, would run even if one of the wires was disconnected, although in speed it was not absolutely synchronous with the supply. In fact, if the wire was removed while the motor was running over the half speed it continued increasing in speed up to its usual rate."

"But did you find the motor with the one circuit disconnected as powerful as before?"

"Of course, this was not to be expected, and we found that we could get about two-thirds of the work out of a single-phase motor that we could out of a multiphase machine of the same size. The efficiency, too, was considerably lower. These experiments led me to investigate the means of starting alternating-current motors on single-phase circuits, as I found that once started there was no difficulty in keeping them at work. I tried with self-induction, capacity, and resistance effects to obtain a difference of phase in starting between the current in the two windings of a motor, and after a long series of experiments I determined to devote my energies to the perfection of the capacity arrangement. I found that electrolytic cells had a large capacity if the solution was correctly chosen. We have now adopted the constructions as follows: a series of iron plates is fixed in a box arranged to form capacity and resistance in series, the solution surrounding the plates being a solution of water and soda, and with this arrangement we can easily obtain a difference of phase of about 90deg. between the self-induction and the capacity circuits."

"Have these water capacities been a success in practice?"

"At first we had difficulty with the containing vessels, which we used to make of wood, the trouble being that the solution soaked through and the reduction in capacity affected the starting of the motor. After that we tried stoneware containing vessels, but these it was difficult to obtain sufficiently uniform in shape. At length we have succeeded in obtaining an enamelled-iron containing vessel, which answers perfectly in every way, and enables our motors to be started without the slightest trouble."

"How do you account for the fact that alternating-current motors have not been more largely used in England?"

"The reason, in my opinion, is the great variation in the frequency employed at the various stations, combined with the fact that at high frequencies alternating-current motors are not so efficient. To illustrate this to you, I would remind you of the fact that the speed of the motor is a simple function of the number of poles and the frequency of supply. Hence, if high frequencies are used, you must either increase the number of poles in your motor, or else allow it to run at an abnormally high speed. It is an acknowledged fact that to make small motors with a large number of poles is both costly and inefficient, therefore the high-frequency alternating-current motor is not so good as one to be employed on our standard frequencies of from 40 to 50 complete cycles per second. A good comparison occurring to me is to state that it is, in my opinion, as absurd to make small motors with a large number of poles as it is to build a big direct-current dynamo with only two poles, or to build a small continuous-current dynamo of one or two horse-power with six or eight poles."

"You do not, then, approve of the design of large two-pole direct-current machines?"

"For outputs above 50 kilowatts I always make my machines four-pole or more, and I am sure that more economical and efficient designs are thus to be obtained."

"As regards the system of supply, what general rules do you follow?"

"In laying down plants where the main demand is for lighting with a few small motors as well, I always use single-phase; when the supply of power and light is approximately equal, I prefer the two-phase system, and, again, when the power supply much predominates, I always adopt three-phase

"And why do you make the last-mentioned distinction?"

"Because, as you will readily see, with a three-phase system of distribution each of the three circuits is dependent on the other two, unless the load is arranged between the terminals and a fourth wire connected to the neutral point of the generator windings; whereas a well-designed two-phase alternator with a three or four wire circuit may be loaded fully in one phase without materially affecting the tension in the other. Thus you will see that on account of the complications involved in the former system the latter is much to be preferred."

"Up to what pressure do you wind your alternators?"

"Up to 5,000 volts we always generate the pressure in

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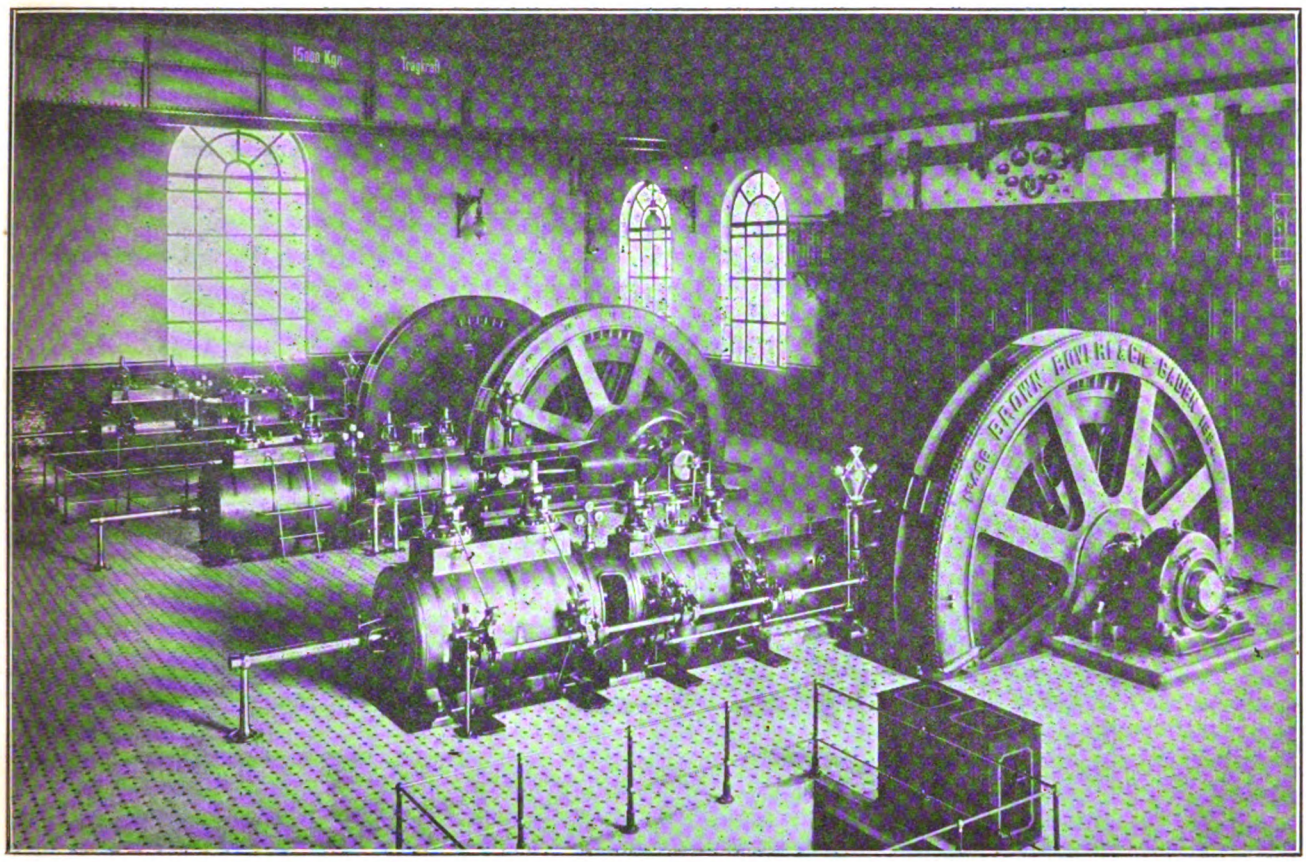
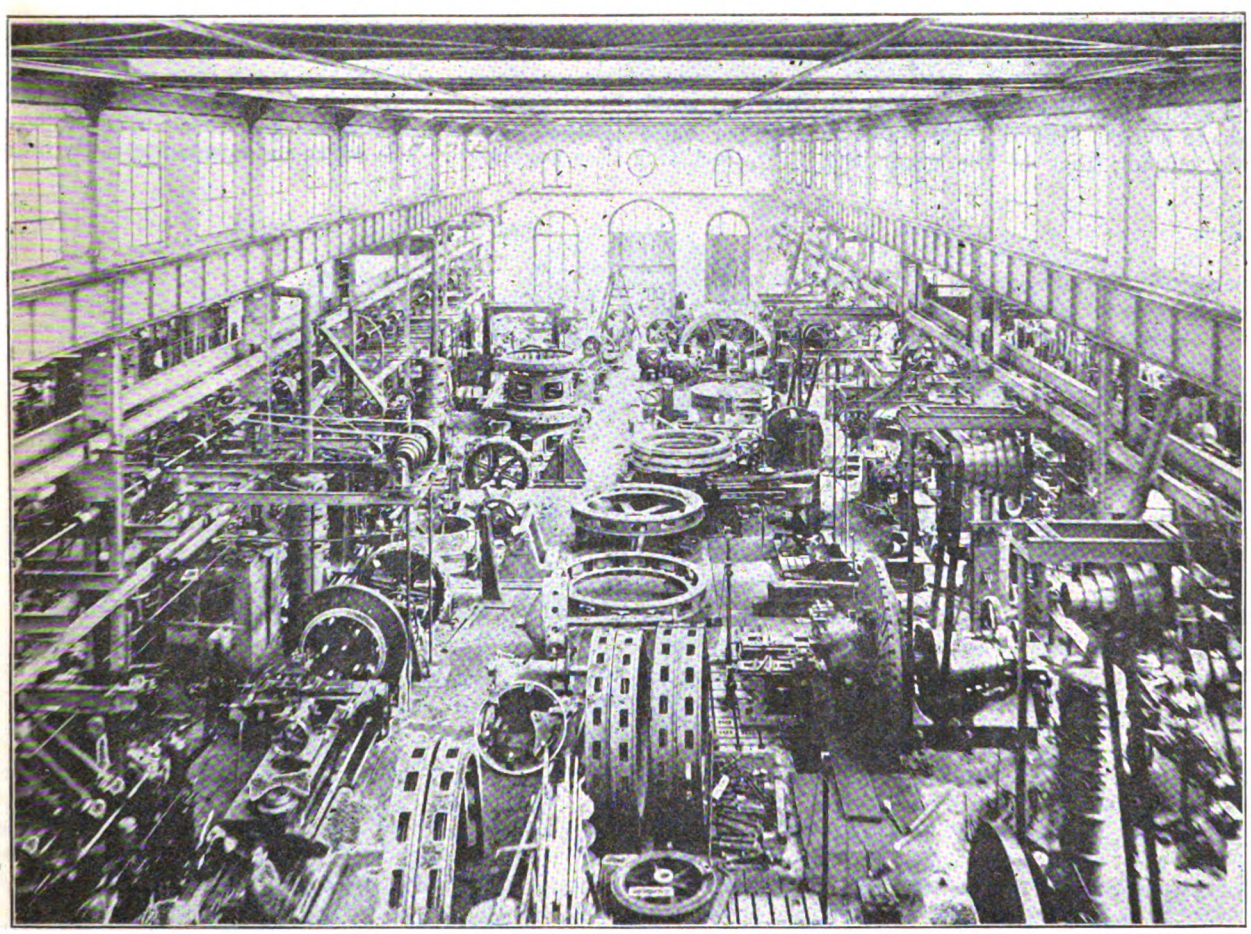
the alternator, and this pressure is sufficient for transmission work up to 10 miles. At the receiving stations we transform down for small motors, but I have built a 110-h.p. motor for 5,000 volts, which has now been running for over a year, and am at present building one 100-h.p. and two 65-h.p. motors to work direct at this tension, besides a large number of other sizes for 1,000, 2,000, and 3,000 volts."



Installation Work of Messrs. Brown, Boveri, and Co.



Large Machine Bay at the Works of Messrs. Brown, Boveri, and Co., Baden.

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"With the large transmission work that you have in hand, what do you find the mean output of your machines to be?"

"The average output of the machines supplied last year was over 100 h.p. each, and I see no reason why this figure should not be exceeded during 1895."

"I can see," I remarked, "that the large amount of available water power in Switzerland gives you great advantages for electrical transmission; but I should like to ask you what you find the average cost of a water-power plant where no large engineering works have to be constructed."

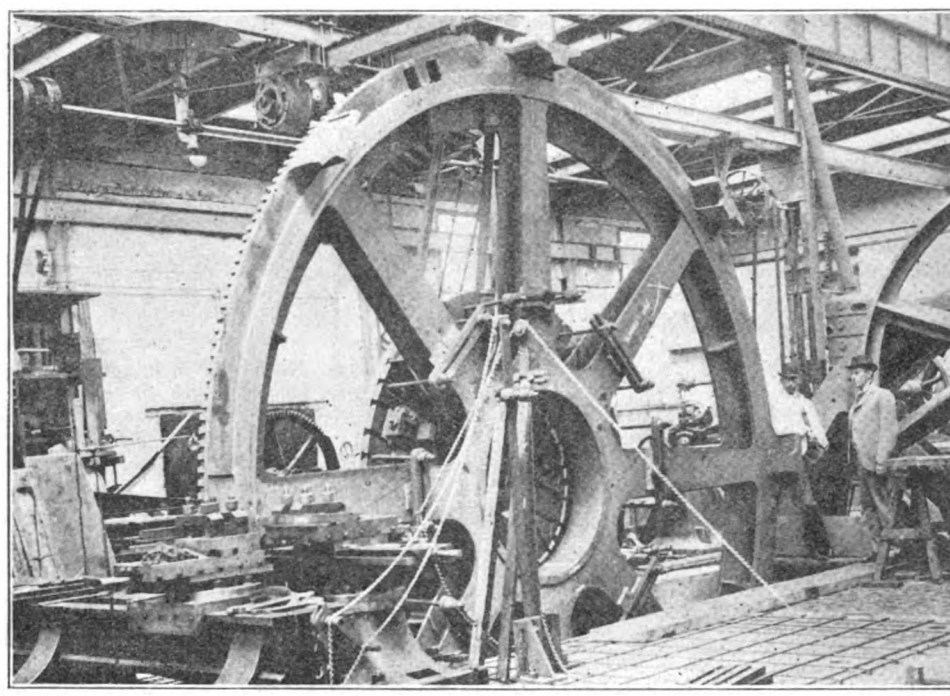
"I should state the average cost of turbines and water-works to be from 800f. to 1,000f. (£32 to £40) per horse-power output; that of the generating plant, including alternators, switchboards, etc., 100f. (£4) per horse-power; and the line, which is, of course, a very variable item, I should put at from 50f. to 100f. (£2 to £4) per horse-power. In fact, the whole cost you may take as averaging 1,100f. (£44) per horse-power."

"I see, Mr. Brown," I ventured in conclusion, "that this amounts to about £60 per kilowatt output, which is approximately the cost of a complete steam plant in England."

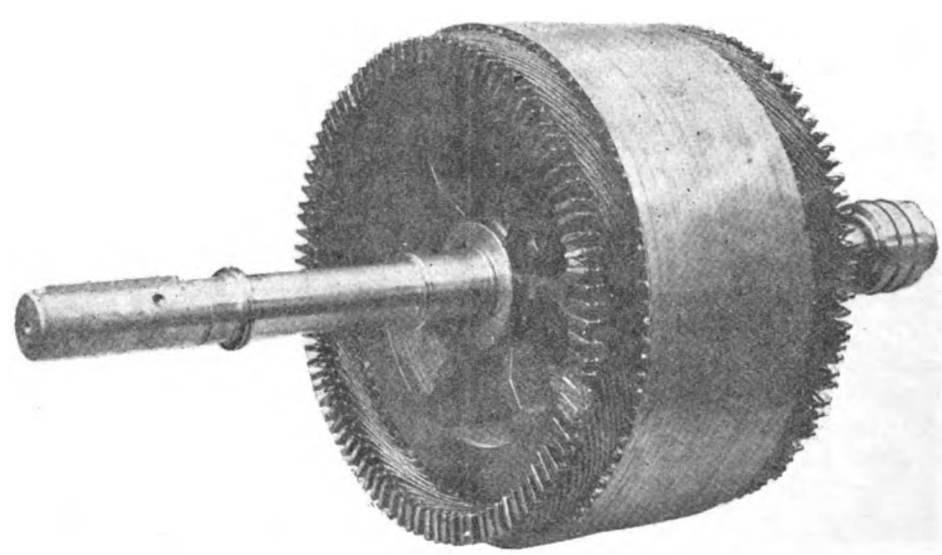
"Of course," he hastened to explain, "it is in the annual upkeep that we gain over a steam plant as in the inaccessible spots in which we can place our electrical generating plants the water power is exceedingly cheap."

MESSRS. BROWN AND BOVERI'S WORKS.

The walk through these works, under the personal guidance of Mr. C. E. L. Brown, was most interesting, both on account of the large size of the machines under manufacture and also to the great care shown in the various details. The works, which were only started some four years ago, have grown most rapidly, and when I visited them a new addition was almost ready to receive the machinery. The works are maintained solely on work on order, nothing being made for stock. At the time of my visit the orders on the books amounted to an aggregate output of 30,000 horse-power, of which about one-third was for continuous-current machines. The whole of the power required is obtained from a water-power station, situated on the river about a mile away. The transmission pressure is 1,000 volts, and the same station also supplies light to the town of Baden. The method of driving the machinery varies with the size of the tools.



Frame of the Large Flywheel Alternators for the Frankfort Electric Light Station (Brown and Boveri).



Armature Wound on the Brown Patent Cylinder System.

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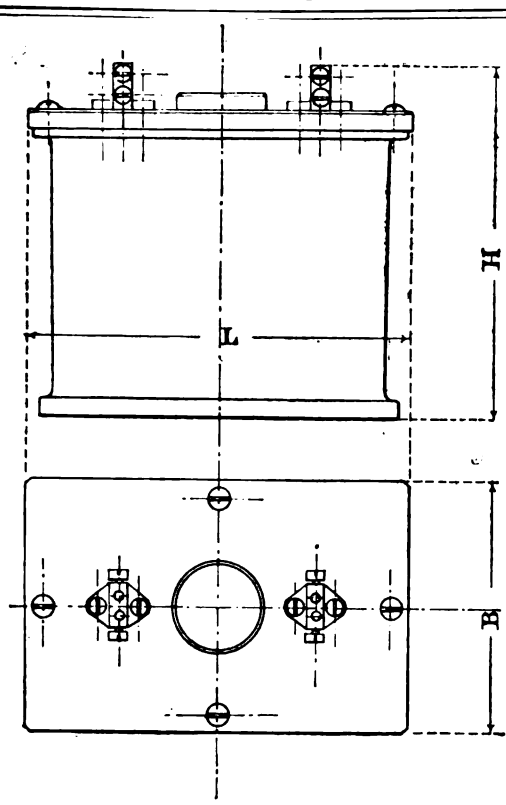
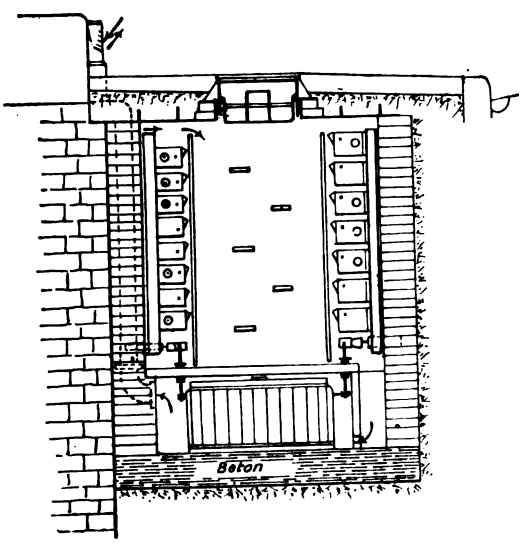
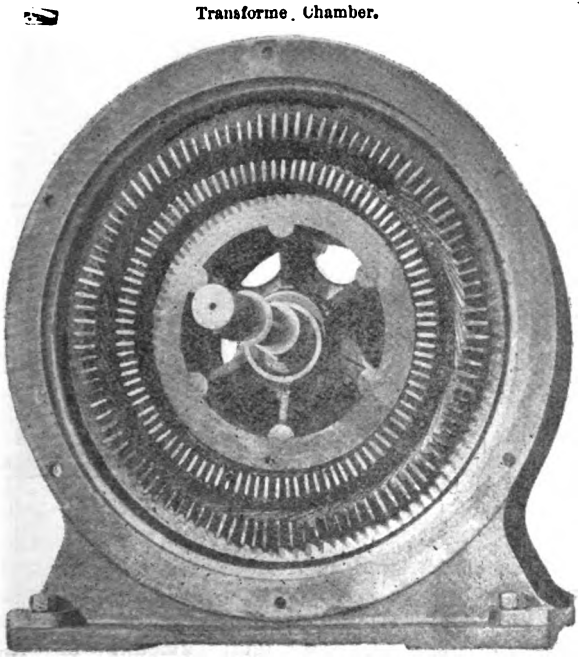


Capacity C

	L.	B.	H.
For motors up to 2 h.p., No. 1	213	138	197
,, ,, 6 h.p., No. 2	273	158	240
,, ,, 20 h.p., No. 3	293	188	282
,, ,, 35 h.p., No. 4	387	237	342
,, ,, 65 h.p., No. 5	443	288	415



Transforme. Chamber.



Motor with Armature and Field Wound on the Brown Patent Cylinder System.

All the large tools have an independent two-phase motor to drive them. In this they are independent of the rest of the works, and this also allows of them being placed with their axis at right angles to the sides of the bay. This can be seen in the illustration of the heavy machinery department, and the arrangement greatly facilitates the transport and attachment of the work. Owing to the works being specially designed for dynamo and alternator work, a large number of special machine tools have been laid down, which greatly assist in the rapid execution of the orders.

The Brown system of armature connection is of special interest. By it all the arms and connections are kept on the same cylindrical surface area, then as the conductor forms the connection the number of soldered joints is reduced in the ratio of about 5 to 2, as compared with the usual English practice. Two examples of this method of winding are shown in the illustrations.

COUNTY BOROUGH OF SALFORD ELECTRIC LIGHT WORKS.

The electric light works of the Salford Corporation, situated in Walness-road, Lower Broughton, were formally opened last week by Mr. Councillor R. Holland, chairman of the Gas and Electric Lighting Committee, in the presence of the mayor (Mr. Alderman Mottram), the mayoress, Mrs. Holland, and other ladies, the town clerk and the members of the Council, the gas engineer (Mr. Shonbridge), the superintendent of the electric light station (Mr. Turner), the borough engineer (Mr. Corbett), the borough analyst (Mr. J. Carter Bell), and others.

Mr. Councillor HOLLAND, in handing over the works to the Mayor on behalf of the Corporation, said that in 1892 the Council decided to provide electric light for the borough, and directed the Gas Committee to take the necessary steps to carry out their wishes. The Council at that time did not intend to spend more than £15,000 upon the installation, but from the replies to a circular which the committee sent to probable consumers, it was evident that this sum would be inadequate, and on this being reported to the Council, they agreed to extend the scheme to the extent of £30,000, and to apply to the Local Government Board for power to borrow £50,000 to cover the first cost of the installation, and to meet future extensions. The amount actually paid to the present time is £29,206, and the balances due to the various contractors on the expiration of the period of maintenance, will increase the expenditure to £34,338. The committee engaged Messrs. Kincaid, Waller, and Manville, electrical engineers, of 29, Great George-street, Westminster, to devise a scheme of supply and prepare the necessary drawings and specifications. The committee have adopted the high-pressure alternating system, by which the current is supplied at a pressure of 3,000 volts through concentric copper cables, insulated with special impregnated fibrous compound laid in cast-iron pipes. This pressure is reduced by transformers at consumers' premises to about 100 volts. There are three sets of engines and dynamos at the generating station, each set capable of supplying 2,500 8-c.p. lamps alight at one time, or to 2,800 lamps connected to the mains, it being found that only about 60 per cent. of the lamps connected are alight at the same time. As it is necessary to keep one of the sets of plant in reserve, the producing power of the station is equal to supplying 8,300 8-c.p. lamps connected to the mains. The cables have been constructed to supply 17,000 8-c.p. lamps, and will therefore meet the requirements for a considerable time. The committee purchased a plot of land, on which to build the generating station, adjoining the River Irwell, so that the water from the river could be used for the condensing engines which have been adopted. The land acquired is large enough to allow of any extension of the works that may be required ultimately. The buildings, which have been erected by Mr. Samuel Warburton, of Manchester, for the sum of £6,600, consist of an engine-room, faced inside with glazed bricks, a boiler-room, pump-room, workmen's messroom, stores, offices,

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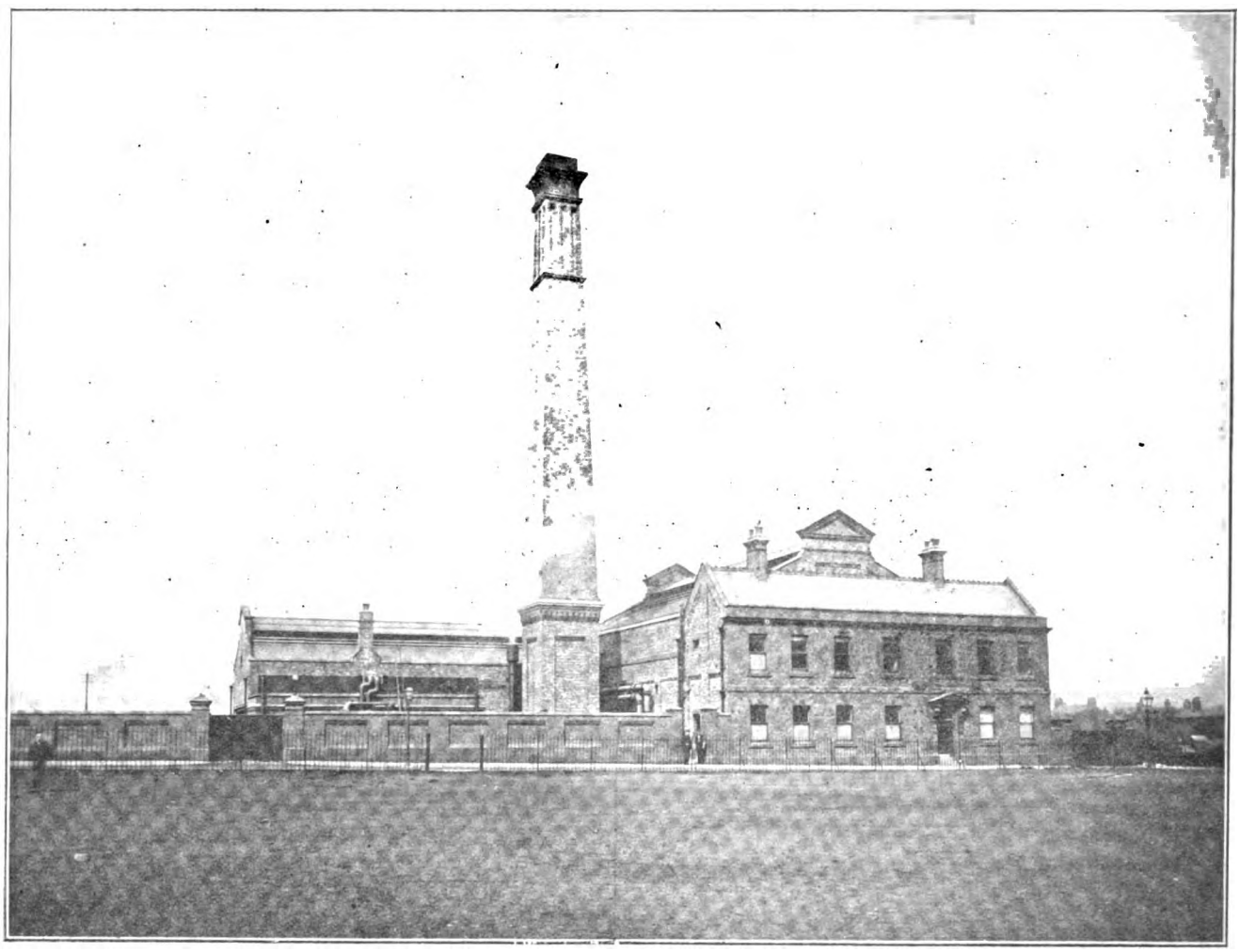
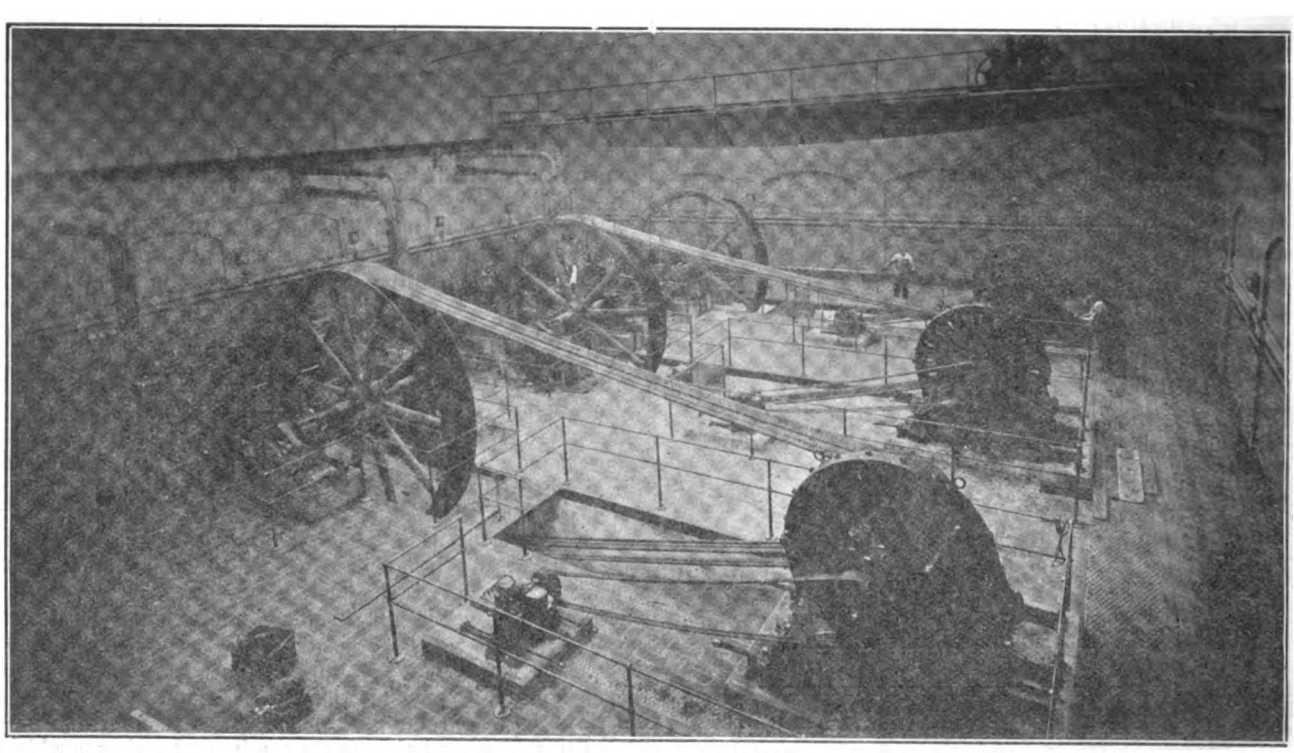
switchroom, and testroom. The buildings are faced externally with Ruabon pressed bricks, combined with terra-cotta, and have a very handsome appearance. There

Patricroft, at a cost of £4,309. These engines drive the alternator dynamos by means of cotton ropes. The dynamos and exciters were supplied by Messrs. Mather



Salford Central Station.



Salford Central Station—Dynamo-room.

are three sets of slow-speed horizontal compound-condensing engines of 200 nominal horse-power each, working at 160lb. pressure, and running at 85 revolutions per minute. These were supplied by Messrs. Browett, Lindley, and Co., of

and Platt, Limited, of Salford, and are driven at the rate of 500 revolutions per minute. Messrs. Mather and Platt, Limited, also supplied the switchboard and electrical instruments, the total amount of their

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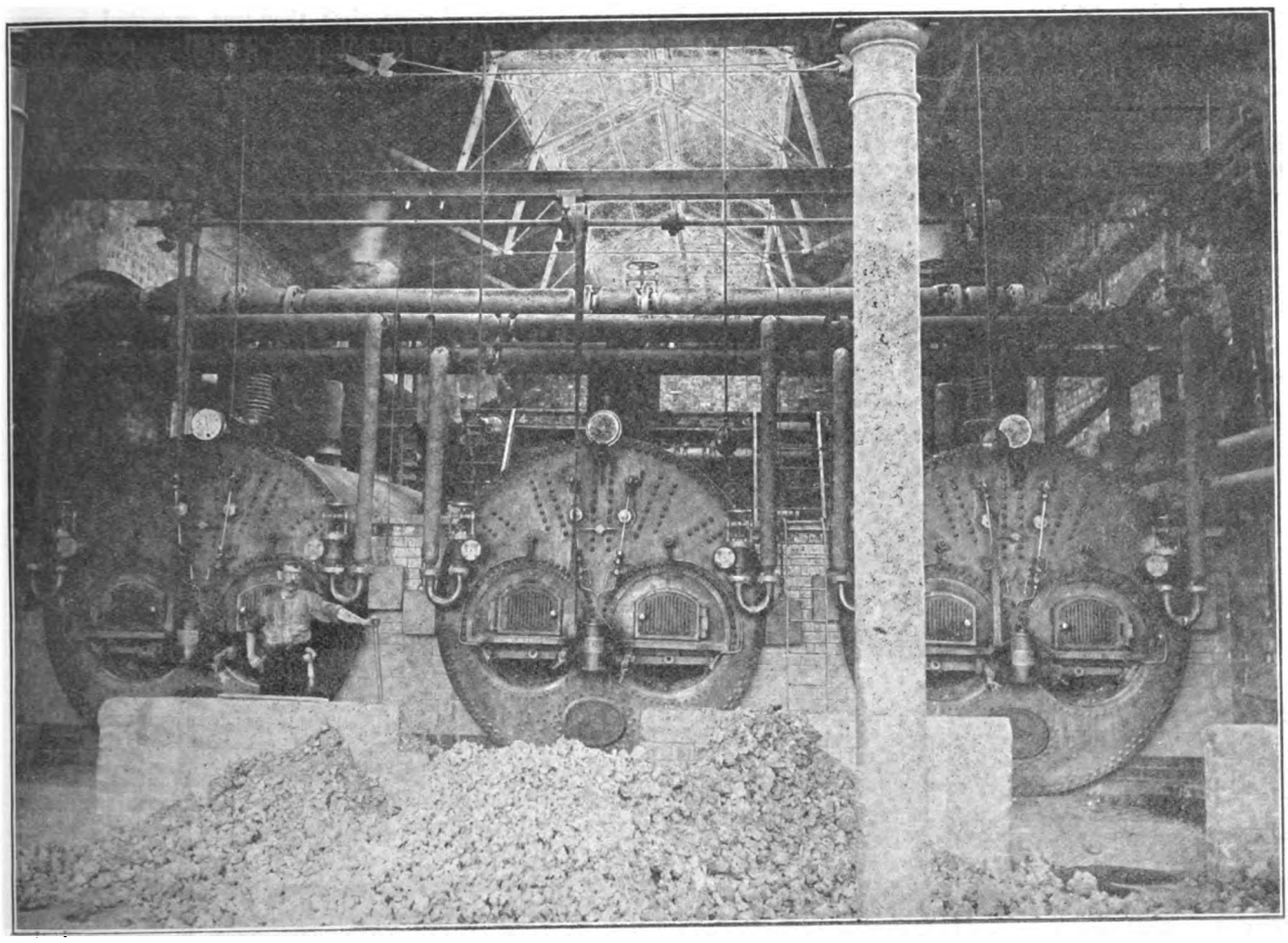
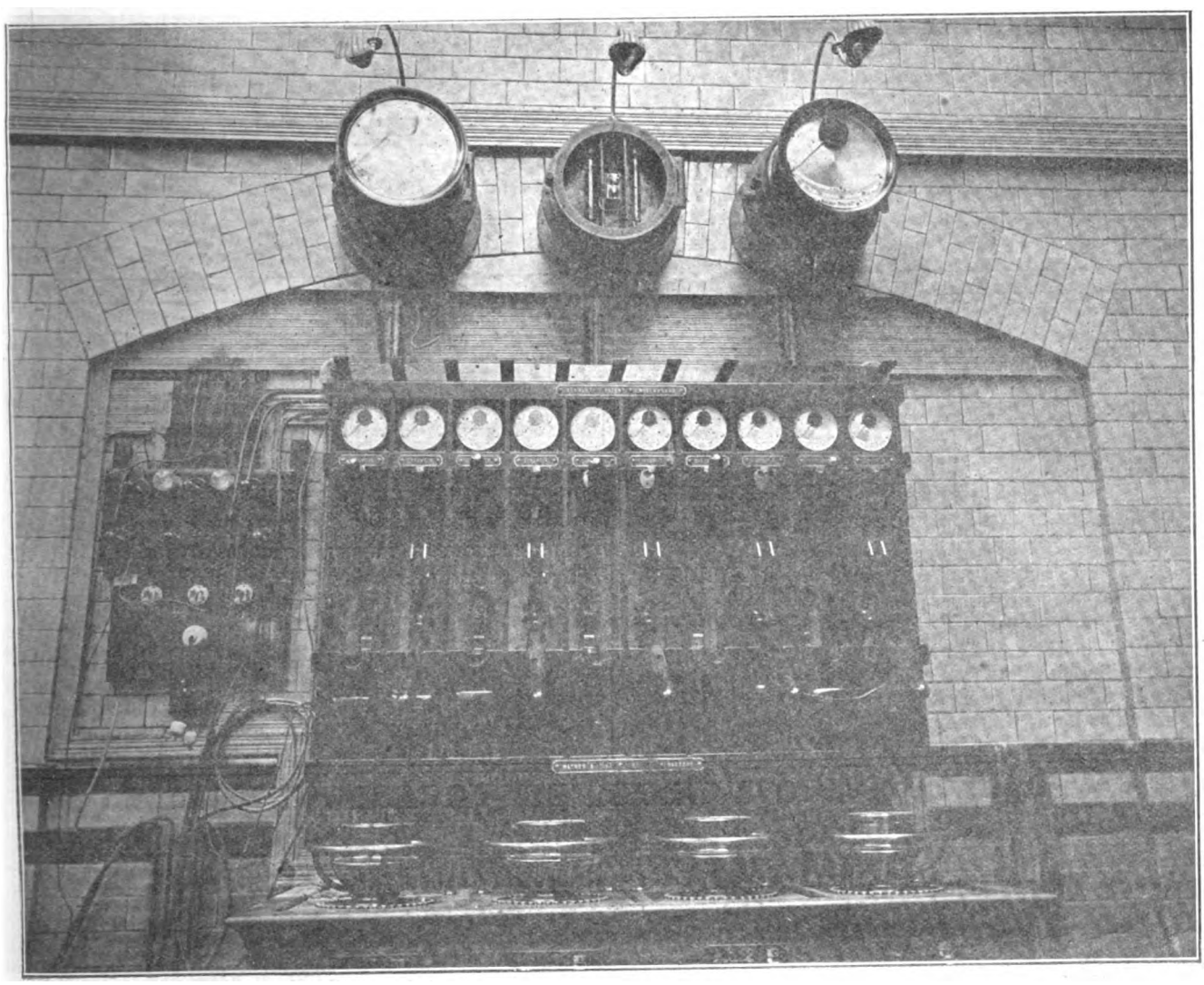


Salford Central Station—Boiler Battery.



Salford Central Station—Switchboard.

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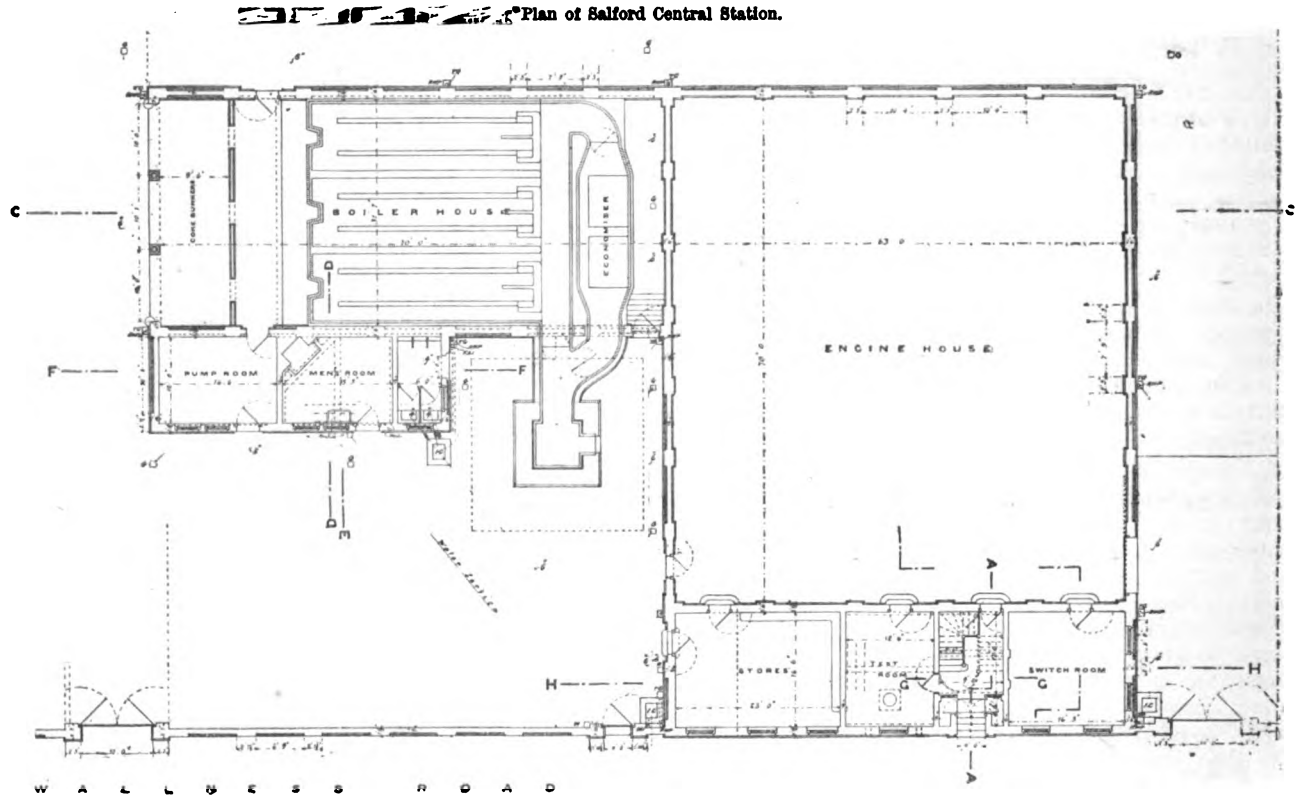
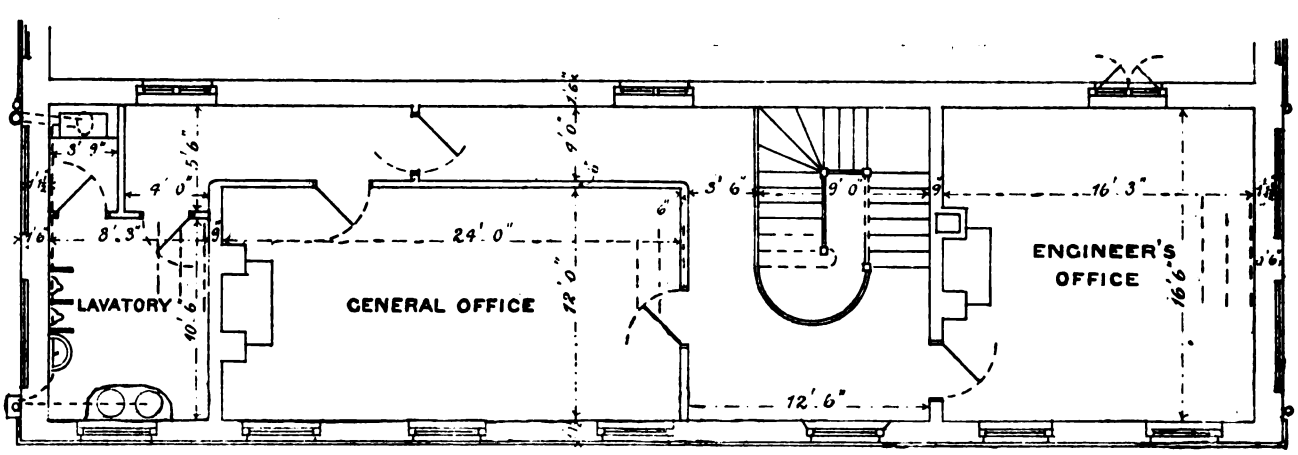
contract being £3,150. There are three Lancashire steel boilers, fitted with mechanical stoking appliances, economisers, etc. They are intended to work at 160lb. pressure, and were supplied by Messrs. Tinkers, Limited, Hyde, at a cost of £3,704. The fuel to be used in them is coke from the Corporation gasworks. From trials that have been made, it has been found that not only has gas coke the great advantage of being a clean smokeless fuel, but it is a very economical one for steam-boilers. The mains are laid in three circuits as follows: Circuit No. 1—from the generating station, passing through Camp-street, Fenney-street, Bury New-road, as far as Mayfield-road, with two branches, one along Singleton-road and Upper Park-road, the other along Park-street and Old Hall-road. Circuit No. 2—from the station along Lower Broughton-road, Broughton-road, Blackfriars-street, as ar as the

Plan of Salford Central Station.





First Floor Offices, Salford Station.

bridge, Chapel-street, The Crescent, and Broad-street, as far as Frederick-street. Circuit No. 3—from the station along Irwell-road, Frederick-street, Broad-street, and Eccles Old-road, as far as Claremont-road. These circuits will be extended from time to time as the demand for current increases until they are spread over the whole borough. At the present time the Corporation have 19 customers, who have altogether about 1,000 lamps, and there are applications from others for a supply for about 500 additional lamps. It is anticipated that a great many more applications will be received when the lighting season commences. The charge for current at present is 7d. per unit, but the committee intend to reduce this as soon as they are able to do so.

The CHAIRMAN said that although the contractors had taken a great deal more time than was expected in completing their work, great pains had been taken to make every part substantial and satisfactory in every way, and he felt that the Corporation had a work thoroughly well equipped and of which they might be proud. He hoped the results obtained from it would be equally satisfactory, and be a source of profit to the ratepayers. He had much pleasure in informing the mayor that the work entrusted to the Gas Committee by the Council was now completed, and everything ready for supplying current to the consumers.

The MAYOR said it gave the mayoress and himself great pleasure to be present and to take part in the inauguration of the works. The electric light undertaking was a most important addition to the responsibilities of the Corporation, and one that he felt sure would prove a source of great benefit to the ratepayers. As an engineer, he had taken great interest in the works, and had watched them carefully whilst in process of erection. He was satisfied that they had a most excellent installation, creditable alike to the contractor and to the Corporation. The boilers, engines, and dynamos were first rate of their kind, and would bear comparison with any others in the country. The Council was much indebted to Mr. Holland, and the members of the Gas and Electric Lighting Committee, for the pains they had taken in carrying out the work entrusted to them. He had pleasure in asking Mrs. Holland to start the engines and turn on the current.

Mrs. HOLLAND then proceeded to start the engines and switched on the current, and amid the cheers of those present the engine-room and other parts of the station were instantly brilliantly illuminated.

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ELECTRICITY IN MINING WORK.

BY T. B. A. CLARKE, B.A.

No department of our industries perhaps promises more scope for the development of electric appliances than coal-mining. In almost every mine the problem arises how to convey energy to a distant point. The road by which this point is reached is in very many cases tortuous, narrow, and low; and these considerations make it of prime importance that the apparatus by which the energy is conveyed should be flexible, easily repaired, and especially take up little room. The electric wire or cable satisfies all these conditions in a very remarkable and unique manner. Even if electricity were the least efficient, instead of being, as it is, the most efficient means of transmitting energy, it would, for the reason above stated, be a very formidable competitor of any transmission system now in vogue.

It is impossible in the course of a short article to examine in detail how the various difficulties inherent in electric mining work are met. I propose to consider more fully in further articles the following subjects: (1) electric lighting of collieries, including surface works, underground roads, and portable electric safety lamps; (2) electric pumping, main, dip, and sinking; (3) electric haulage by endless rope, main and tail rope, and locomotive; (4) electricity at the coal face, coal cutting, drilling, and blasting.

In these articles accounts will be given of the most important installations at work, accompanied by tests, results, criticisms, and comparisons with other means of transmitting power. In this article I propose to examine the general conditions which limit the use of electricity in our mines.

1. *Danger of Exploding Inflammable Gas.*—This is the most important matter to be considered, and it is one about which a great deal of misconception exists. Of course, the ventilation of most of our mines nowadays is good enough to prevent any accumulation of gas in a working face. Gas, however, is constantly being given off and swept away by the air current, but there is a danger to which some seams of coal are particularly liable—namely, a sudden outburst of gas which the air current cannot dissipate for a considerable time, sometimes several days. The ingenuity of electrical engineers has for a considerable time been exercised in providing electric apparatus which shall work with safety in the most inflammable mixtures of gas and air. It will be well to examine these somewhat in detail, and see how they answer the purpose for which they were designed.

To consider the case of the motor first. A well-designed continuous-current motor working within its load and in good condition should not spark appreciably. An accident may easily occur, however, which may set up sparking at the brushes and cause an explosion. It has been clearly shown, by experiments at the Aldwarke Collieries of Messrs. John Brown and Co., that excessive sparking will explode gas, hence the obvious precaution is to enclose the brushes and commutator in a case, which either must be gastight or have any openings covered with gauze, as in the miners' safety lamp. The gastight case renders the armature and commutator entirely safe, and if the motor is of the iron-clad type (Lahmeyer) the field-magnet windings will be well protected against any fall of roof which may occur. The objections to this method are, of course, the difficulty of dissipating the heat from the armature coils and commutator, and of giving proper attention to the position of the brushes. The obvious deduction from this is to be sure and have your motors of ample power. In that case neither heating nor sparking will give trouble. The method of having openings in the casing covered with gauze cannot be too strongly condemned. It is a mere plausible travesty on the safety lamp. Suppose, for instance, that the casing is charged full of gas, it is, of course, exploded; the gauze, or even the whole casing, would be blown off, the armature would be burnt, and the flame would inevitably explode the gas inside. In the case of a safety lamp the flame is extinguished by an explosion of gas inside the lamp; in the case of a motor it would not be, and hence the gauze casing is no protection at all. This difficulty is now being attacked by some manufacturers in a radically different manner—namely, by using motors driven by single, double, or three-phase alternating currents, and dispensing altogether with commutator and brushes. This is an interesting departure, and may give good results in time. At present, however, there is not sufficient data to go upon to pronounce definitely whether the continuous-current motor is in any danger of becoming obsolete. For myself, I think not. The Frankfort-Lauffen plant and others since show plainly that good and efficient work can be done by motors of this type, but it is certainly premature to say that these motors could successfully cope with all the various classes of work to which continuous-current motors are put in a coal mine. The other day I examined carefully a number of such machines which an enterprising electrician hopes to put on the market to the discomfiture of the continuous-current machine in mining work. The opinion I came to was that while for some classes of work they would be quite suitable, for others, and those cases when gas was most likely to be met, they were quite unsuitable. However, they certainly dispose of the sparking difficulty, and were that all that had to be faced they would ostensibly be a satisfactory solution of the question.

Another point, however, remains, and that, in my opinion, is of far greater importance than the motor question. I mean the damage to cables, connections, and switches. The contact of the cores of two cables, or the severance of either, means a momentary spark or flame. It is, of course, argued that to have an explosion two conditions must be simultaneously fulfilled: firstly, damage must be done to the cables; secondly, gas must be present at that moment. If the cables are carried along a road swept by the intake air the danger is small, but still it exists, and many managers are unwilling to add one more risk to the list of those which already exist in a mine. The most prominent attempt to meet this difficulty is by having your cable surrounded spirally by, and insulated from, a thin wire, which is connected separately to a small fuse on the switchboard on the surface. In case the cables are torn down and broken, the thin spiral wire stretches, and ultimately, on the severance of the main wires, carries the whole current. This blows the small fuse at the top, and the current is interrupted without spark. So far so good. Accidents to cables happen, however, in many different ways from this, and if both cables were jammed together violently, say, by a load of trucks, a short-circuit would occur, which would undoubtedly cause a momentary flame of intense heat. A short time ago I examined an installation down a fiery pit where these cables were used, and the manager told me that twice in one month such an accident as that stated above had occurred. In both cases an intense momentary flame had been the result.

The safest way to lay cables in a fiery mine is to run them underground in iron pipes. Of course, this is very costly, and does away with many of the advantages of electricity. Trouble may also ensue from the floor rising, if soft, and breaking the pipes. The question is a most serious one, affecting as it does the lives of everyone in the mine, and any electrician installing such work in fiery mines incurs a very heavy moral responsibility. My opinion is, that where the pit is fiery electricity is not suitable owing to the great risk involved. To make myself perfectly clear, I would explain that I do not consider it safe to run cables through any part of a mine where there is liable to be either an accumulation of gas or an outburst. Happily, however, such mines do not preponderate, and there is ample scope for the manufacturer of electric machinery in those well-ventilated and moderately gassy seams without trying to push his wares into places where grave risk is incurred and tragical results by no means improbable. Should any such mishap occur, the check to the progress of electricity in mines would be enormous. A hard-and-fast rule would be laid down by mine inspectors as to the use of electricity. Electric plant would be enhanced in cost by the necessity of providing a number of precautions superfluous if the place is fit for electricity, and useless certainly if the place is unfit.

(To be continued.)

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THE GLASGOW TRAMWAYS.

Municipal action, in whatever direction it takes, is watched with considerable interest, because upon it to a large extent depends the welfare of the inhabitants under the municipalities. What, then, are the main features of municipal work? First, we have questions of morality under the supervision of police and magistrates, but the consideration of these will not detain us. Then we have the sanitary problems, to be solved by the engineer and officer of health. These, again, need not detain us.

Perhaps the distribution of water will be considered a sanitary problem. Whatever opinions may be held upon other questions to be mentioned below, we imagine there are few who will differ as to the advisability of the personal and properly safeguarding and the sanitary works being under the control of the local authority. Further, there will be no divergence of opinion about the construction and maintenance of streets being under that control, and, so far as we are concerned, we have always advocated the control by the local authority of the artificial light, whether it be gas or electricity. We are, however, not so certain when the question comes to haulage, whether on tramways, railways, or streets. In this article, however, we shall restrict our remarks to tramway working. Having agreed that the roads and streets must be under the control of the authority, it becomes a delicate question how far that authority should work the vehicular traffic. Viewed from the standpoint of initiation of reforms, the municipal control is out of question. It is difficult to conceive a municipality being in advance of its time, and yet improvements are generally introduced by men in advance of their fellows. Would any municipality have of its own initiation adopted the electric light without the push and enterprise of such men as Jablochkoff? They usually want to see first that a new development is practical; they do not want to experiment, but to use the costly experimental results of others. This part of the subject again divides itself into two phases, those developments that the inhabitants must participate in and those that they may. Water, light, and air must be had, and the veriest dolt cannot but see that nothing short of the best can ever lead an authority to rest. The ratepayers will not look too closely into an expenditure undertaken to ensure better water, light, or air, but they will look with suspicion upon a suggestion made in the earlier stages of development of some means of accelerating or bettering locomotion. So much for the initiative question, but the matter is simplified when it comes to the use and control of something proved. Better, quicker, cheaper means of moving from one part of a town to another must benefit the community generally, so that tramways having been proved in these directions may possibly come within those undertakings that should be controlled by the local authority. Of course, another strong argument to favour this view is that the roads and streets can be maintained in better repair when the controlling authority is undivided. A still stronger argument than has yet been mentioned is a financial one, and this is one that appeals very forcibly to the

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ratepayers. The working of the tramways may be a big financial success, and some considerable relief to the rates may be obtained from the enterprise. To us this argument seems of the weakest, for whatever can be advanced in its favour may also be advanced in favour of every other business in the town, be it the baker's, grocer's, or rag and bone merchant's. Let us, however, see what Glasgow has done as regards its tramways. The abstract gives place here to the concrete. Glasgow owns the tramways, and, after a fairly long experience of leasing the working, took the sole control of the working into its own hands from July 1, 1894. The income for eleven months' working, the financial year for the city ending May 31, is £226,414. 3s. 4d., the total expenditure, including interest, the maintenance and renewal of permanent way, buildings, machinery, plant, horses, harness, rolling-stock, and equipments, is £202,209. 9s. 2d., leaving a credit balance of £24,204. 14s. 2d. This is an excellent result when the period of working is considered, and the enormous difficulties in taking over and starting, as it were *de novo*, on a given day are examined. We wonder that the balance was not adverse. The capital account was £552,956, now depreciated from credit balance to £543,762. The whole text, sermon, and moral may be summed up in a few words. Here is one of the largest and most enterprising cities in the kingdom investing over half a million in a business closely connected with the business welfare of the community, successful from the first moment of its undertaking and promising greater success in the future. Shall its example be followed, and if followed, will the imitators still go on the old lines of horse traction, or will they admit that electric traction has claims that indicate it would be still more successful than the older system. The average cost per train mile is 9·34d., and 1·12d. represents the credit balance of receipts over expenditure per train mile. The mileage for the eleven months has been 5,192,031; the passengers carried 57,104,647; the average receipts per mile being 10·26d. It will be seen that the success is due to the enormous traffic, and this is no doubt due to the cheapness and excellency of the service.

REFUSE DESTRUCTION AS APPLIED TO ELECTRIC LIGHTING PURPOSES *

BY E. MANVILLE, M.I.E.E.

The question of the destruction of ashbin refuse is one that has, as you are well aware, occupied the attention of local authorities for a good many years past, and during the past three years the attention given to the subject has materially increased, owing, probably, in the first place, to the difficulty of finding suitable tips at which to deposit the refuse; secondly, to the increasing cost of the disposal of refuse; and, thirdly, to the various opinions that have been expressed as to the amount of available energy that can be derived from the refuse if burned under proper conditions. This last reason has stimulated the energies of local authorities, but I think I may say that the necessity of disposing of it in such a manner as to in no way endanger the health or comfort of the ratepayers has at least equally assisted in the most mature consideration being given to its disposal in a sanitary manner, even if such disposal has to be accomplished at a cost exceeding the older-fashioned methods. Fortunately, however, excepting in those places bordering on the sea coast, and even in many of these, the cost of the disposition of ashbin refuse in the most sanitary manner at present known is less than the carting and barging away and tipping it in suitable or unsuitable spots. I allude, of course, to the perfect cremation of the ashbin refuse in what are commonly known as dust destructors. If I were to attempt in the short space of the 20 minutes allowed me to describe the various methods and systems on which dust destructors have been constructed, I could do but very scant justice to the subject; and I propose, therefore, chiefly to explain to you a system of dust destructors and boilers at present being erected for the Vestry of Shoreditch, in London, in which the most desirable methods of effectively and absolutely disposing of the ashbin refuse have been combined with the most efficient conceivable arrangements for the production of energy from the heat evolved, without detriment to the thorough combustion of the refuse.

The progress of the design of the dust destructor has certainly been one of slow evolution. In the first days of the design of these furnaces little seems to have been considered beyond the means of burning, or partially burning, the refuse, without any consideration as to the treatment being carried on in a scientific manner; and doubtless this has had a great deal to do with the prejudice that still in many places exists as to the presence of such an installation within a large city or town. Had destructor furnaces been from the very commencement so designed that all the gases produced in the heating and burning of the refuse were thoroughly and completely burned, but little prejudice would probably now exist.

To attain these results, the facts to be borne in mind by designers of destructors are simple. The gases produced by the destructive distillation of ashbin refuse must, to ensure their thorough combustion, be raised to a temperature of at least 1,200deg. F., and to ensure this minimum temperature the mean temperature should not be much less than 1,800deg. F., so that during the operations of clinkering, etc., the temperature of the interior of the furnaces may not fall below the specified minimum of 1,200deg. F. In some designs of destructor furnaces, where the rate of burning of refuse is such that temperatures of only 800deg. or 1,000deg. F. are attained in the destructor cells, this end is provided for by the addition of a secondary fire, over which all the products of combustion from the burning refuse are passed, and which during their passage through this secondary furnace are, by virtue of its heat, raised to that minimum temperature. On the other hand, of late it has become a common practice to burn the refuse under a forced draught at a more rapid rate than previously, and by so doing to raise the temperature of the destructor furnaces themselves to a temperature often attaining, and even exceeding, 2,000deg. F. Designs have been adopted in which all the gases produced in the furnaces are made to pass through the hottest portion of them, in order to ensure their being raised to the maximum temperature before leaving the destructor cells.

This method has proved itself eminently satisfactory so long as normal conditions are maintained in the quality of the refuse to be burned; but I think it is improbable that in any place every load of refuse could be absolutely relied on to contain nothing of a character that might prevent this high temperature being attained, and therefore I believe that, especially in small ranges of destructor cells, means should be provided for adding a secondary fire, even if it be only used for an hour or two occasionally, when the refuse is of a very doubtful description. Proper design and provision of this kind having been made, there can be, I think, no doubt in the minds of those responsible for the erection of dust destructors as to the certainty of complete combustion of the gases taking place, and the entire absence of anything in the shape of a nuisance to the surrounding neighbourhood.

The calorific value of burning refuse has so often been called in question, and such varying statements have been made as to results so far achieved that there is little wonder at the incredulity of many local authorities as to the refuse having any value worth talking about from a steam-raising

* Paper read before the Hull Congress of the British Institute of Public Health.

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point of view. Some of these contradictory statements have been made from sheer ignorance on the part of those who make them, and others on account of the conditions under which the steam raising has been performed, which conditions have involved the loss of a great deal of the heat from the products of combustion before the boilers are reached, and then the complete insufficiency of the boiler-heating surface on which the heated gases act. I have myself heard practical users of dust destructors state that but an extremely small amount of steam can be hoped to be produced with their dust destructor, and therefore with dust destructors in general. Now no doubt the calorific value of ashbin refuse varies in every district according to the nature of the district and the season of the year, but after making due allowance for such differences as might exist under these conditions, some of these statements still seem to be entirely ridiculous to me and to those who, like me, have taken the trouble to ascertain what may be attained in the way of steam raising with ashbin refuse. I have endeavoured in such cases to find out the reasons that have induced these gentlemen to place such discouraging figures upon the calorific value of their ashbin refuse, and I have invariably found that the cause was due to the mixture of foreign substances with the refuse collected from the ashbins. In one prominent case, in which a gentleman well known in connection with dust destructors has from time to time stated that in his belief no such horse power as talked about by others could be obtained from ashbin refuse, I found that his ashbin refuse was enormously diluted with street sweepings before it was burned in his destructor. Of course, it follows that if matter of an entirely incombustible nature is mixed with—if I may term it—pure ashbin refuse, the calorific value of the ashbin refuse may be so reduced that it may be entirely worthless as a steam producer, and I do think it most desirable that where the unusual conditions of the admixture of foreign substances with the ashbin refuse occur, those who talk of the steam-raising powers of ashbin refuse under these conditions should be always careful to mention that it is so mixed. I refer strongly to this point, since several local authorities who, to my personal knowledge, might have erected dust destructors and utilised the steam raised by the combustion of the ashbin refuse, have been so discouraged by these contrary and apparently inexplicable statements that they have abandoned altogether the consideration of a destructor scheme.

As long ago as 1892 the Vestry of St. Leonard, Shoreditch, in London, having in view the erection both of a central electric supply station and of a dust destructor, I, in my capacity of their adviser, strongly recommended them to combine the two schemes. A great deal of careful investigation was carried out on their behalf to ascertain what power might reasonably be expected as obtainable from the burning of their ashbin refuse, and as a result of this investigation I felt enabled to assure them that all the steam required for the estimated electrical output likely in the first instance might be obtained from a properly designed dust destructor. In arriving at this opinion I experimented on a large scale with samples of ashbin refuse collected from various parts of Shoreditch, at a season of the year when household fires were not much in use, and I found it was extremely rich in carbon. Indeed, when the unsorted refuse was burned directly in a boiler, it evaporated as much as 3lb. of water from and at 212deg. F., and my opinion that the steam required could be obtained from the burning of this refuse in a properly designed arrangement of destructor cells and boilers, was founded on the supposition that only about one-third of the calorific value of the refuse would be utilised in the boilers, after due allowance had been made for the complete and perfect combustion of the ashbin refuse and its gases.

The Vestry thereupon resolved that such a combination should be erected forthwith. It took some time to secure a suitable site for these buildings and other municipal buildings the Vestry wished to erect at the same time; and about four months ago I was enabled to proceed with the plans of the arrangement originally proposed by me. A number of tenders were received for carrying these plans into effect, and ultimately the contract was awarded to Messrs. Manlove, Alliott, and Co., of Nottingham, on the following basis, and the works are now in process of erection. They consist essentially of a destructor-house in which is arranged a range of destructor furnaces, 12 in number, in two banks of six each placed back to back, with a working floor in between. The destructor cells are arranged a pair on each side of a Babcock and Willcox boiler, there being thus in all six boilers. Each of these boilers has a heating surface of about 1,400 square feet, and the pair of cells on each side of it are arranged to discharge their products of combustion under the boiler tubes immediately above the level of the firebars, these latter being left in the boiler, together with the fire-doors, in the same manner as if the boiler were being erected without the accompaniment of dust-destructor cells. Each cell is arranged with double flues, one leading to the boiler, as aforesaid, and the other direct into the main flues. Each destructor has a grate area of 27 square feet. The main flues are arranged above the floor level and underneath the working floor, and are in duplicate, each boiler and cell being able to discharge its gases into either or both of the main flues. This arrangement of duplicate flues is essential in the combination of a dust destructor with an electric lighting station, as the dust carried over with the products of combustion from the cells into the main flue must be removed at moderately frequent intervals, whilst the working of the main flues can never be discontinued owing to the necessity of continuous steaming of the boiler, and this duplicate arrangement of flues enables one flue at a time to be cleaned out, the products of combustion of all the boilers and all the cells being taken into the remaining flue during that time. At the end of the main flues is placed a chamber, which for the present will serve the purpose of a dust-depositing chamber, but may in the future, if found desirable, be divided up to contain an economiser with its requisite by-pass flue. This chamber leads into the main chimney shaft, which is 150ft. in height from the floor level, and is provided with a circular gallery around its base, into which this chamber leads, and between which gallery and the main shaft are a number of small openings, the whole being so arranged that the products of combustion have to swirl round the gallery to enter the shaft—a provision to ensure the final depositing of any fine dust carried by the gases through the depositing-chamber. The chimney shaft is lined right to the top with firebrick, and a ventilated air space left between the firebrick lining and the main structure of the shaft, to avoid the outer walls being appreciably heated. In the London district this is quite desirable, since the rules of the County Council provide for such thickness of walls in the chimney shaft that the unequal expansion and contraction of these walls would be such as to lead to the disintegration of the brickwork, the inner skin coming into contact with gases possibly at a temperature of upwards of 2,000deg. F. As before mentioned, each boiler has its proper complement of firegrate, firedoors, etc., which are provided for the express purpose of enabling the boilers to be fired by coal alternatively or simultaneously with the absorption of heat from the waste gases of the destructor cells passing through the boilers. This arrangement fulfils a twofold object. First, the provision of the secondary fire before referred to, which is in the most desirable position for further heating the destructor gases immediately they enter under the boiler, should that operation be requisite, and having the further advantage that the heat so produced is ultimately completely absorbed by the boiler and thus turned into profitable use; secondly, to add to the steam-raising power of the boilers when the heat of the destructor gases is not sufficient to produce all the steam required, or, when the destructor cells attached to a particular boiler are out of order, to enable the boiler to be entirely fired by coal or coke.

Each of the destructor cells and the boiler furnaces is fitted with two systems of forced draught, one being an air blast, the other an induced blast produced by steam jets. The air blast is produced by three sets of fans coupled to and driven by electric motors, two out of the three fans being sufficient to supply 16,000 cubic feet of air per minute, the maximum quantity that could possibly be required, and to produce it at a pressure up to 3in. water gauge. The steam blast is derived direct from the boilers, and is arranged as a continuous system, so that

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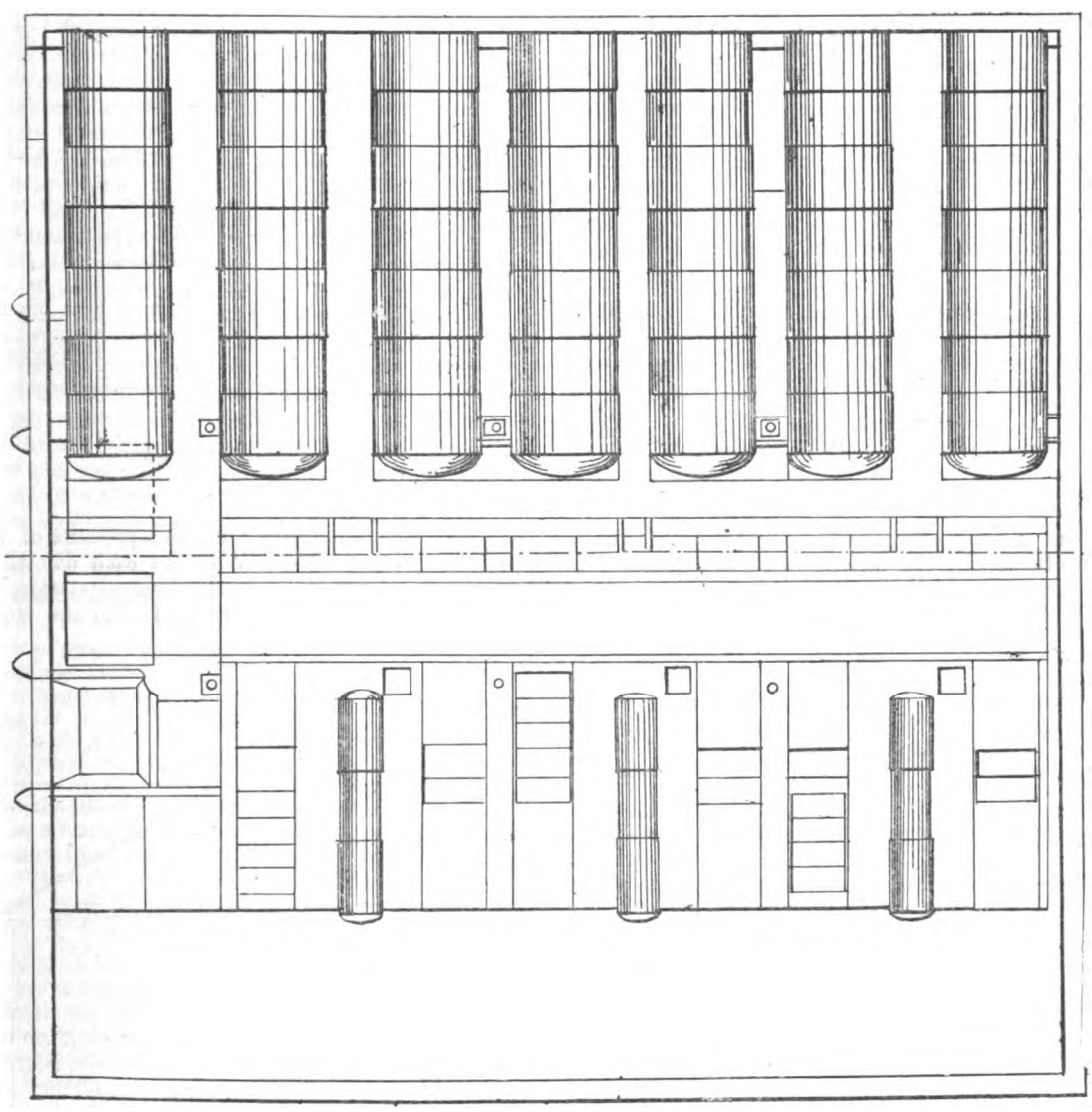
cells adjoining a boiler not in use can still obtain their steam blast from the other boilers in use. So much divergence of opinion still exists as to the relative merits of the fan blast and induced steam blast, that the Vestry, acting under my advice, settled to instal both systems, when they will be able to use either or both in combination as may be found most desirable in practice.

Ten out of the 12 dust-destructor cells are capable of burning with ease the 20,000 tons of ashbin refuse per annum which have to be dealt with by the Vestry. The charging of the cells with the refuse is to be effected in a manner which, though not novel, will perhaps be more effective than heretofore. The space available for the construction of an inclined roadway involved the use of a gradient of 1 in 15, not an unusual gradient for such purposes, but at the same time decidedly detrimental to the longevity of the horses drawing the carts, and it was



General Plan.

therefore decided to replace the elevated roadway with two electric lifts. Either of these lifts is capable of lifting a full load of, say, three tons of refuse, and, being in duplicate, no hindrance can happen to the delivery of refuse should one of them be put out of order. The refuse is tipped from the carts into a tipping wagon, sinking below ground level and raised by the lifts afterwards to a floor considerably above the level of the tops of the dust destructor and furnaces. These tipping wagons are then hauled by mechanical means into any desired position along the range of furnaces, and the refuse tipped from them into storage bins reaching from this floor to the level of the tops of the destructor furnaces. From these storage bins the refuse is discharged as required into charging trucks made after Messrs. Bulnois and Brodie's patents. These charging trucks are divided into compartments so arranged that the charging truck being brought over a horizontal door in the top of and at the back of the destructor cell, doors in the bottom of the truck corresponding with each compartment may be opened simultaneously with the door at the top of the cell, and the exact charge of refuse dropped through into the cell. There it falls upon an inclined hearth at the back of the firegrate, whence it is raked down through the clinkering doors in front on to the firegrates themselves. This arrangement enables a great deal of manual labour to be dispensed with, the whole of the transference of the refuse to the particular destructor it is destined to feed being accomplished by means of electric motors, and the storage bins referred to have a capacity equal to 60 tons of refuse, which will enable the furnaces to be fed during the night-time, and also during the greater portion of the time that intervenes between Saturday afternoon and Monday morning. The storage bins being placed well above, and out of contact with the hot brickwork of the destructor cells, the stored refuse is preserved under the most favourable conditions.

As mentioned previously, the principal object of the whole of this arrangement of boilers and cells is to get the maximum output of steam. I have calculated that the electric light station will require steam at 120lb. pressure at the rate of 12,000lb. per hour for four hours a day, 6,000lb. per hour for three hours a day, and 2,000lb. per hour for the balance of the 24 hours, or in all 100,000lb. weight of steam for 24 hours, and the contractors who tendered for the carrying out of the works were invited to state what proportion of this weight of steam they would guarantee should be raised by the consumption of ashbin refuse only. Many of them, including Messrs. Manlove, Alliott, and Co., undertook that no coal should be required to raise the requisite amount of steam daily. It must be borne in mind that the difficulty to be met in the combination of a dust destructor with an electric lighting station, from a

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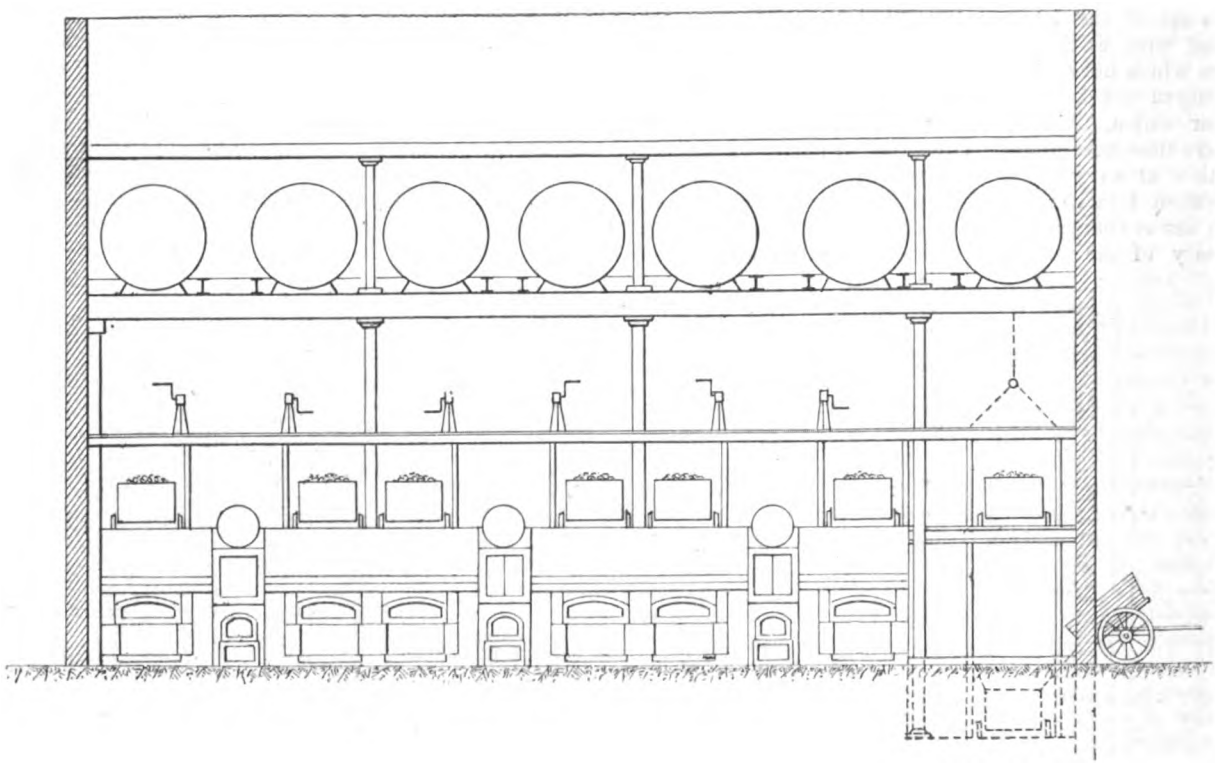
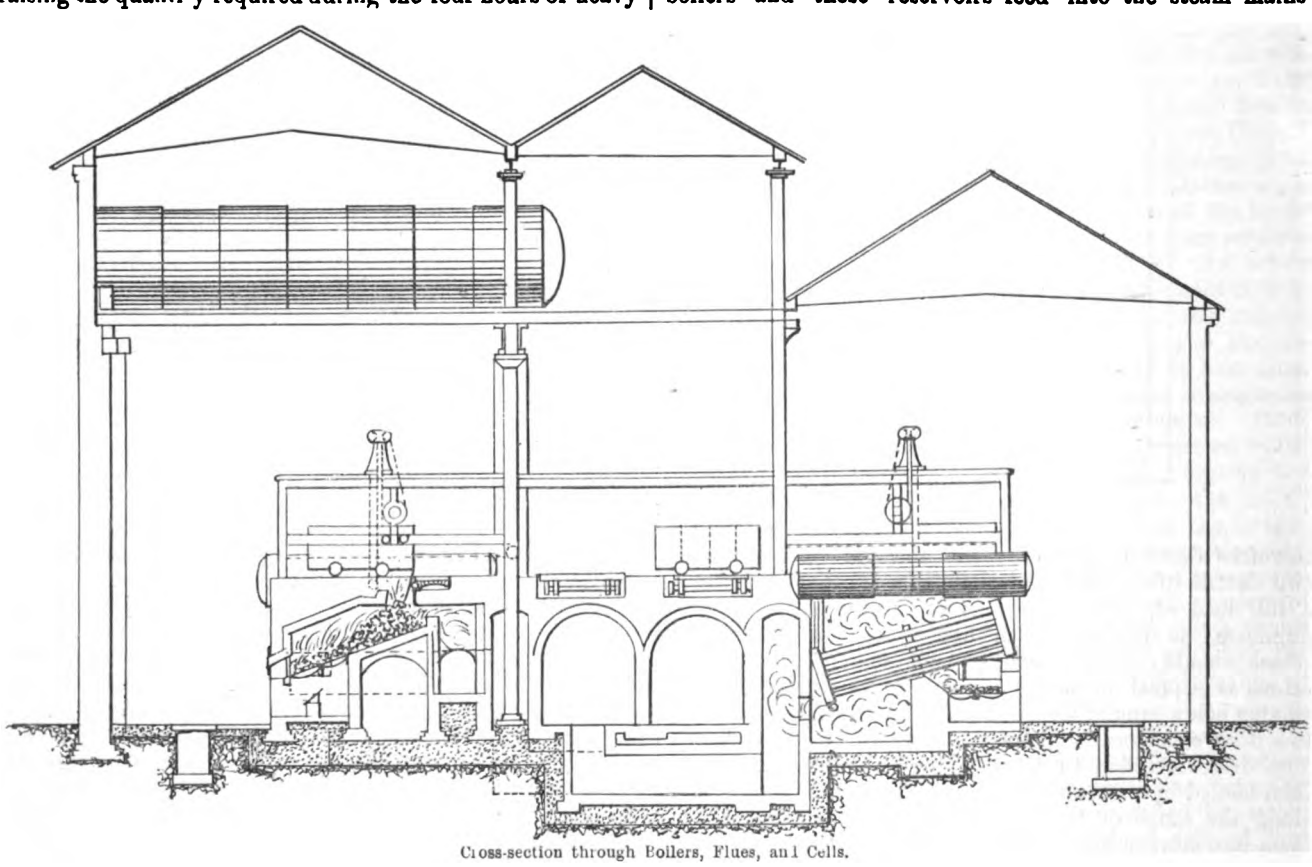
steam-raising point of view, is that whilst the refuse is being burned at an approximately even rate during the whole day, the steam for the electric light station unfortunately is required in very varying quantities, varying from a very small quantity during the greater portion of the day to a maximum, six or seven times the minimum, during the four hours of heavy load; and whilst the furnaces might be quite capable of raising the total quantity of steam required at an even rate, they might be incapable of raising the quantity required during the four hours of heavy load. To meet this difficulty, Messrs. Manlove, Alliott, and Co. propose to instal in conjunction with the boilers the patented thermal storage system of Mr. Druitt Halpin, and the arrangement of thermal storage reservoirs proposed for Shoreditch is shown on the accompanying sketches. Seven reservoirs, each 35ft. in length and 8ft. in diameter, are provided and connected up to the boilers, thereby accumulating the energy. The temperature in the reservoirs is never allowed to drop below the equivalent of 120lb. steam pressure to the square inch, but during the accumulation of the energy developed by the boilers the temperature is raised in both the boilers and these reservoirs until a temperature equal to a pressure of 200lb. per square inch is attained. When in each day the time of heavy load is attained at the central station, both the boilers and these reservoirs feed into the steam mains supplying the engines, and as the energy taken by the engines considerably exceeds that which the boilers are capable of generating, the pressure in both boilers and reservoirs gradually falls until the minimum of 120lb. is again reached, and the energy represented by this difference in temperature is that which has been taken up from the



Sectional Elevation along Front of Cells



Cross-section through Boilers, Flues, and Cells.

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boilers during the day time by the thermal storage reservoirs. Thus is the energy, that would otherwise be wasted, accumulated and carried on to the time when it can be utilised by the electric light engines. An additional and not unimportant advantage accrues from the use of these thermal storage reservoirs, inasmuch as the feed-water is pumped into the reservoirs and not into the boilers, and hot water at the actual boiler pressure is allowed to gravitate from the reservoirs into the boilers to make up for the evaporation in the boilers. At the minimum temperature at which the storage reservoirs are standing, practically all the inorganic salts held in solution in the water are deposited in the reservoirs, and the boilers are fed with water free from these impurities. They therefore remain perfectly clean and unscaled on their water surfaces, and are always working at their highest efficiency, whilst the precipitate in the thermal storage reservoirs is in the shape of soft mud only, since the plates of the reservoirs are not exposed to the action of the fire, and they can be with perfect facility cleaned from this precipitated mud.

The combination of a thermal storage system with a set of dust destructors and boilers will, I believe, appeal to all of you as an ideal arrangement for the utilisation of the steam produced by the latter. You will notice that very high pressures are to be attained, 200lb. being the maximum. I have myself heard papers read before societies, in which it has been stated that higher pressures than 70lb. or 80lb. cannot be attained in boilers fired with destructor gases. Statements of this kind do not require much comment from me. It will be obvious to all of you that with destructor gases varying from 1,200deg. to 2,000deg. F., such a pressure as this, or, indeed, if it were desired, a much higher pressure of steam can be obtained. Perhaps those who have made such statements will be reassured when they find a firm of standing guaranteeing, under heavy penalties, the successful issue of a dust destructor thermal-storage scheme in which a pressure of 200lb. to the square inch has to be attained without the use of coal.

THE ELECTRIC LIGHTING OF BANGOR, WALES

The following report has been drawn up by Mr. F. H. Medhurst, the electrical engineer appointed by the Bangor City Council to assist them in the consideration of the question of introducing the electric light into Bangor.

In order to be in a position to supply electricity for public and private purposes from an electric power central station the Corporation must apply for a provisional order, or, if time presses, the local authority may make application to the Board of Trade for an electric lighting provisional license, which will have to be confirmed within seven years by a provisional order, granted by Parliament. As I understand that the gasworks are already taxed to practically their full capacity, I should recommend the Corporation to apply, in the first instance, and at the earliest possible date, for a provisional license, because it will not be possible to obtain a provisional order this year. Every provisional order or license must contain four schedules: The first, setting forth the area within which the order or license is intended to apply; the second, giving a list of streets in which distributing mains must be laid within two years of the date of the order or license; the third, giving a list of streets not repairable by the local authority; the fourth, stating the maximum price which it is proposed to charge for electric energy under the order or license. In this case the license, if applied for, would of course be applicable to the whole of the borough of Bangor, and I have marked on the accompanying plan the streets which I should suggest for the compulsory area, though it should be borne in mind that the Corporation will have the option of laying distributing mains in any other streets as well, and would, most likely, do so if the probable demand appeared to justify the necessary outlay. I have, however, based my estimates on an initial scheme to supply the compulsory area only. A Board of Trade unit (equal to $1\frac{1}{3}$ e.h.p. per hour) is the commercial unit of electrical energy; it is usually called simply "a unit," and will maintain a 10 c.p. incandescent electric light for $33\frac{1}{3}$ hours. I should recommend that 6d. be the maximum charge per unit to private consumers, and at this rate the cost of using a 10 c.p. incandescent light for an hour will be rather less than $\frac{1}{5}$d.

Taking into consideration the fact that the total length of streets embraced in the proposed compulsory area is about 5,500 yards, and that the principal shops, private houses, and public buildings of the town are included in the area, I am of opinion that I am well within the mark in counting on having 4,000 lights of 10 c.p. each in electrical connection with the mains within a year from the opening of the works. The mains are proportioned for the above number of lights, but as experience in other places has conclusively demonstrated that more than half of the lamps wired are never likely to be simultaneously alight, I have provided generating machinery at the proposed central station to supply rather over 2,000 lights of 10 c.p. alight at the same time, with, however, ample spare plant.

On the occasion of my visit to Bangor on June 5, I was most anxious to ascertain whether it would be possible to rely on water power, in whole or part, to supply the energy for driving the generating machinery. During the morning Dr. Grey Edwards and Mr. Smith Owen kindly conducted me to the Penrhyn Mills and to the Coetmor Mills. I am of opinion that a power station could not be of any practical utility for electricity supply purposes unless the stream were damned up, or some other method of water storage resorted to above the Coetmor Mills. But such storage would necessarily take place during the daytime—in fact, during the time when people would not be requiring to use artificial light. The daytime is, however, the time of greatest activity at the mills, and I was, therefore, forced to the conclusion that no scheme for utilising water power for lighting Bangor electrically could be carried out without serious interference with existing water rights. But even if this difficulty could be overcome, it would be necessary to erect steam plant, to be used only in case of severe frost or of exceptional drought, and I find that, taking everything into consideration, the possible saving in coal and wages would be more than swallowed up by the interest and sinking fund on the increased capital outlay that would be involved by having to erect water power, plus a complete stand-by steam plant, by the extra cost of mains, and by the cost of improving the water power.

During the afternoon of June 5, you, sir, and Dr. Grey Edwards were good enough to escort me on my tour of inspection, and amongst other things you showed me three sites that would probably, I believe, be available for the erection of electricity supply works. The sites were: (1) adjoining the gasworks; (2) on the seashore (used, now, I understand, as a refuse tip); (3) on the Euston-road. Site No. 1 appears to me to be the most convenient, and if the Corporation can obtain the land at a reasonable price I should recommend that the proposed works be erected on this site. It is fairly central, and water can be obtained without expense for condensing purposes—a fact which must produce an economy of about 25 per cent. in fuel. Site No. 2 is made-up ground, and its adoption might easily involve a heavy outlay for foundations for the chimney shaft. Site No. 3 has the advantage that a siding might easily be made from the railway line, and the effect would probably be to so reduce the cost of coal by the amount that would otherwise be paid for cartage, etc. But the siding cannot be made without expense, and the fact of condensing the water being available at the gasworks site more than compensates for the saving of about 1s. per ton for cartage.

The system I strongly recommend for Bangor is the high-tension alternating-current system, with transformers in sub-stations, and a low-tension network of mains for private supply. The current will be generated at a pressure of 2,500 volts at the generating station, and it will be conveyed by means of well-insulated stranded copper cables, drawn through cast-iron pipes with drawing-in boxes at intervals of about 100 yards to the various sub-stations marked on the plan. At these points transformers will tap the high-tension mains. The low-tension mains will likewise consist of well-insulated stranded copper cables, drawn into cast-iron pipes (but not the same pipes as those containing the high-tension cables), with junction-boxes at intervals of about 50 yards. The boilers will be two in number (one spare), and each will evaporate 2,500lb. of water per hour when working under normal conditions. It will, however, be possible to "press" them up to 3,500lb. of water per hour, if necessary, for short periods of time. The main engines will be three in number (one spare), will be vertical, compound, and condensing, and will work at about 260 revolutions per minute. The alternators will be coupled direct to the engines, and will be on the same bed-plate. There will be two exciting steam dynamos (one spare). In the event of the lighting scheme alone being carried out, I should propose to provide for the small amount of current that may be required during the daytime by employing an alternating-current motor dynamo coupled direct to a continuous-current dynamo and a small set of accumulators. During the night the steam alternators would be employed to charge the accumulators through the intervention of the motor dynamo, and during the daytime—in fact, for two shifts of eight hours each out of three—the accumulators would supply current to the continuous-current dynamo (which would then be used as a motor), and this would revolve the alternating-current motor (which would then be used as an alternator), thus giving a supply of alternating current to the mains. The practical effect of this arrangement is twofold: it enables the services of stokers to be dispensed with during times of light load—say, for 10 hours out of 24—and thus causes a considerable saving in labour; and, secondly, it tends to reduce the consumption of coal by enabling the steam-engines to work at

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nearer full load than they would otherwise do. The capital expenditure for the scheme I have recommended and described will be, approximately, as follows: Two boilers, economiser, feed pumps, and steam and exhaust pipes, £1,800; surface condenser and circulating pumps, £350; three 30-kilowatt steam alternators and two steam exciters, £2,400; buildings and foundations, £2,000; switchboard, £500; day load plant, £450; travelling crane, £130; mains, laying and making good, £4,920; site, £200; unforeseen expenses and contingencies, £250—total, £13,000. Statistics prove that the average price to be expected per lamp of 10 c.p. per annum is about 10s. Therefore, the total revenue from 4,000 lamps will be £2,000. The Corporation can, I am informed, borrow 3¼ per cent., whilst 2¼ per cent. must annually be set aside to form a redemption fund for liquidation of the loan. We have then the following results—Revenue: 4,000 lights at 10s., £2,000. Working expenses: coal, £240; engineer, £150; wages, £400; oil, waste, and stores, £66; repairs and maintenance, £190; interest and redemption on £11,300, £719. Total, £1,792. From the above figures it will be seen that from the very commencement of the undertaking a fair net profit is likely to be made after payment even of interest and sinking fund. But it must be borne in mind that when the demand comes to exceed the 4,000 lights on which I have based my estimates—and those are well on the safe side—the future revenue will certainly increase in a much higher ratio than the expense. For example, the capital cost of a scheme for 6,000 lights would be about £16,000, but the probable net profit would be not less than £500 after payment of interest and sinking fund. There appears no reason why the demand should not equal 6,000 lights of 10 c.p. in three or four years' time. Then, again, the Corporation may rest assured that if it does not itself see its way to carrying out the electric lighting scheme, some outside company will very likely apply for and (unless the Corporation itself takes action) obtain a provisional order, and in that case the local authority would very possibly find itself in the position of having to pay a very large bonus in a few years' time for the privilege of purchasing rights which ought never to be forfeited.

I have most carefully considered this matter, and the suggestions I am about to make will, I trust, prove of interest to the Corporation. The capital expense of an electric tramway on the overhead trolley system from the Clock Tower to Garth Point will be equivalent to an addition of about £8,600 to the cost of the lighting installation. In arriving at this estimate I have taken into consideration the fact that the same boilers and engines and the same buildings (with some addition for an accumulator battery) will be used for both lighting and traction purposes, and the extent to which the schemes have been combined will be most readily appreciated when I state that the cost of the tramway scheme alone would, if carried out in the best manner, not be less than £12,000. I propose a single track only, with, however, a loop or siding half-way between the termini, so that the cars may pass one another halfway. I would suggest that each main engine at the generating station be coupled direct to a 30-kilowatt continuous-current dynamo, as well as to its alternator, the engine being placed between the alternator and the dynamo. I suggest also having a set of 255 accumulators; the tramway will derive all its energy from this battery. The engines at the generating station will charge the batteries—which will also be at the central station—during the hours when the tramway is not working, and as the charging current will always be equal in amount to the difference between the full output of the engines and the current required for lighting purposes, it follows that during the whole period of charging the engines will be working at full load, whilst for one shift out of three the engines will be at rest, and the stoker may be sent away. The importance of working the engines at practically full load almost all the time during which they will be running may best be judged from the fact that whereas on trial it is quite possible to get a unit of electrical energy from about 2lb. of coal, yet the average consumption of coal at electricity supply works cannot be far short of from 8lb. to 15lb. per unit sold. By combining the electric light and the electric tramway scheme, the standing charges will not be very materially increased, whilst each undertaking will naturally be debited with its fair proportion, so that, after very careful calculation, I have come to the conclusion that the working expenses of the electric lighting department will be reduced by about £210 if the electric tramway be put down and the two concerns be worked together. I also believe that the electric tramway could not possibly fail to bring increased custom, and hence increased profits, to the pier now in course of construction. I assume that the charge be 2d. per journey from the Clock Tower to the pier, and *vice versâ*. It may also be assumed that the two cars (and I do not propose that more than two cars shall be in use at the same time) start from their respective termini at the same time, pass one another half way, and make five journeys per hour each, including stoppages. The cars will be constructed so as to carry 32 passengers each, and I do not think it extravagant to assume an average load of four passengers per journey per car. Then each car would therefore earn 8d. per journey, or 3s. 4d. per hour. The two cars would therefore earn 6s. 8d. per hour between them. Now, the cars would be at work for 12 hours per day, so that the gross earnings would be £4 per day. The cars would probably not run during church hours on Sunday, so that the gross revenue may fairly be taken at £4 a day for 313 days, and £2 per day for 52 days. Therefore the gross revenue works out at £1,356. Now, the total working expenses should certainly not exceed 5d. per car mile, or £626 in all. This would leave a profit of £730. The capital required has already been stated at £8,600. Interest and sinking fund, calculated as in the electric lighting scheme, amounted together to £473, leaving a net profit of £257. But to this sum should be added any saving in the working expenses of electric lighting scheme, as well as an increase of revenue to the new pier. The former I have already estimated at £210 per annum, and I think that £150 is a very cautious allowance to make for the increase of revenue which the pier is almost certain to derive from this convenient and cheap mode of access. The total net advantage, then, which is in my opinion most likely to accrue from the direct and indirect operation of the electric light is certainly not less than £817—and this after payment of all interest and all other capital charges, and after making allowance for maintenance and depreciation.

I think the only conclusions to be drawn from the above considerations are: (1) That electric lighting works have every prospect of proving a useful and profitable undertaking at Bangor, and that if they be carried out quite alone they would most likely prove a source of considerable alleviation to the rates in from two to five years' time; (2) that an electric tramway, in combination with the electric lighting works, will not only earn a fair profit, but must tend to increase the revenue of the pier, and decrease the working expenses of the electric lighting undertaking; (3) that the advantages of the combined scheme are great indirectly, and that directly there is almost certain to be a net profit of over £800, if the combined scheme be carried out; (4) that as the capacity of the gasworks is already taxed to the utmost, no time should be lost in passing the necessary resolutions to carry out the electric lighting scheme, and that for economical reasons the electric tramway should be carried out at the same time, the total capital expenditure of the combined scheme being about £22,000. Finally, I can only say that if, notwithstanding the fact that I have used my utmost endeavours to express clearly and logically my reasoning and my conclusions, there still remain any details upon which the committee would wish to have additional information, I shall be very happy to keep any appointment that may be suggested, and to explain fully anything that possibly may not have been thoroughly elucidated.

The proceedings of the Council in connection with this matter appear in our "Business Notes."

LEGAL INTELLIGENCE.

THE BRITISH INSULATED WIRE COMPANY, LIMITED, v. PRESCOT URBAN DISTRICT COUNCIL.

This case came up again last week in the Court of Appeal before the Master of the Rolls, Lord Justice Kay, and Lord Justice A. L. Smith.

It was an appeal by the plaintiffs from the judgment of the Divisional Court (Mr. Baron Pollock and Mr. Justice Wright) on a special case stated in an action. On November 18, 1892, an agreement was entered into between the plaintiffs and the defendants whereby the plaintiffs agreed to light with electricity the streets of the defendants' district for a period of five years from January 1, 1893. The agreement provided for the reference of all disputes thereunder to arbitration. The agreement was sealed, but it contained no penalty clause. The plaintiffs carried out the agreement by supplying electric light from January 1, 1893, to March 31, 1895, and were paid the sums due to the end of the quarter ending June 30, 1894. This action was brought to recover £278. 9d. 9d. for the supply from July 1, 1894, to March 31, 1895. The question for the opinion of the Court was whether the agreement was binding on the defendants by reason of its not specifying a penalty to be paid in case its terms were not carried out. By Section 174, Sub-section 2, of the Public Health Act, 1875, "every such contract" (contract made by an urban authority) "shall specify the work, materials, matters, or things to be furnished, had, or done, the price to be paid, and the time or times within which the contract is to be performed, and shall specify some pecuniary penalty to be paid in case the terms of the contract are not duly performed." The Divisional Court held that the provisions of the sub-section were imperative, and that therefore the contract was void, and gave judgment for the defendants. The plaintiffs appealed.

Mr. J. Lawson Walton, Q.C., and Mr. L Sanderson appeared for the plaintiffs; Mr. Danckwerts appeared for the defendants.

During the course of the argument it was stated that the defendants were willing to make the payments, but that the district auditor and the Local Government Board had refused to sanction them. Thereupon,

The **Master of the Rolls** said that it was just and right that these arrears should be paid, and that if this opinion were intimated to the proper authority, the Local Government Board would

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doubtless allow the arrears to be paid, and that a new contract should be entered into containing a penalty clause.

The case was accordingly adjourned, to enable the parties to go before the Local Government Board. Finally, upon the case being called on, it was stated that the Local Government Board would sanction the payment of the arrears, and it was arranged that a new contract should be entered into in substitution for the present one, its terms to be settled, in case of disagreement, by some third party. Upon these terms the appeal was dismissed.—*The Times.*

A DISPUTED CONTRACT.

At the Liverpool Assizes, before Mr. Justice Wills, without a jury, the case of Ball *v.* Ellison and Son has been heard. This was an action to recover money for a lightning conductor. The plaintiff, Joseph Ball, of Oldham, was represented by Mr. Pickford, Q.C., and Mr. Horridge, and the defendants, who are architects in Liverpool, by Mr. Taylor, Q.C., and Mr. A. Rutherford.

The case for plaintiff was that in the summer of 1893 he entered into a contract with the defendant firm to fix a lightning conductor to the chimney of a hospital which the Toxteth Guardians were erecting. The defendants were the architects in the matter. After the contract had been made it was alleged that the character of the chimney was altered, and stouter and longer rods had to be used. Before doing the work plaintiff informed the defendants of the extra requirements, and no objection was made. The work was completed, and there were no expressions of dissatisfaction with it. Ultimately plaintiff sent in his bill for £163. 19s. 6d. to the defendant firm, but it had not been paid.

The defendants, without admitting liability, had paid into Court £57. 10s.

A number of witnesses were called in support of the case for the plaintiff.

The defence was that on the contract the defendants had not made themselves personally liable, but had simply acted for the Toxteth Guardians, who had reaped the benefit of the work. Furthermore, Colonel Ellison, of the defendant firm, expressed dissatisfaction at the way the work was done, and on that ground, and on the ground of excessive cost, he refused to grant plaintiff a certificate for payment.

His **Lordship** decided that the contract was made with the defendants, and gave judgment for the plaintiff for £140 and costs, which included the amount paid into Court.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY.

Mr. Justice Chitty was asked on Saturday to sanction an alteration in the memorandum of association of the Consolidated Telephone Construction and Maintenance Company, Limited. Incorporated in 1881, the Company had a nominal capital of £300,000, divided into 300,000 £1 shares. Various alterations had been made from time to time, and the present nominal capital was £234,938, divided into 47,363 6 per cent. preference shares of £1 each, and 224,850 ordinary shares of 10s. each, and 75,150 ordinary shares of £1 each. All the ordinary 10s. shares had been issued and were fully paid up. The memorandum of association expressed the objects of the Company in very wide terms, but there was now a prospect of profitable trading in matters which were not considered to be covered by the memorandum, and it was proposed to alter the latter so as to give the Company power "to manufacture, buy, sell, and deal in articles, apparatus, and inventions in connection with electricity or to which electric power may be applied, and to manufacture and deal in mechanical apparatus and inventions whether connected with electricity or not," and to alter the title of the Company to "The Consolidated Telephone Construction and Manufacturing Company, Limited." The petition stated that owing to the expiration of patents belonging to the Company other manufacturers were enabled to manufacture telephones in competition with the Company, and there was a large importation of telephonic apparatus from abroad. From these causes the manufacture of telephones and telephonic apparatus had become less lucrative than it formerly was, and the plant and appliances of the Company were only partially employed. It was therefore proposed to go in for the manufacture of scientific and mechanical instruments of all kinds, from which considerable profits were anticipated.

His **Lordship** gave the necessary sanction.

COMPANIES' MEETINGS AND REPORTS.

CROMPTON AND CO., LIMITED.

The annual general meeting of the above Company was held at Cannon-street Hotel on Friday last, Viscount Emlyn occupying the chair.

The **Chairman**, in moving the adoption of the report and accounts, which we printed in our last issue, said that in connection with the reduction in profits there was a satisfactory feature, which was that although there had been a considerable reduction in prices, the falling off in profits was due mainly to the lack of orders in the first six months of the business year. Business had then been so slack that no profit was made, and the whole of the £7,000 profit had been practically earned in the latter half of the year, when the order-book was well filled and the works were very busy. New contracts showed better prices, and business generally was improving. Several changes had been made with a view to greater economy, and in connection with these the accountant's department had been removed to London, and better departmental control had been established. The Court of Chancery had sanctioned the reduction of capital. The directors had hoped that the issue of debentures last January would be fully subscribed, but £82,000 only had been taken up. The item of stock had been slightly reduced, as had investments in subsidiary companies, by writing off. Part of the reduction in profits was due to the purchase of small machine tools, not covered by the depreciation account. There had also been a small loss due to the misreading of a specification. At the last meeting they had anticipated that the electric cooking branch would prove important, and this had turned out to be the case. They had got £1,000 from a French firm for the French rights, in addition to royalties, and they had concluded licenses for Switzerland and Austria-Hungary. It had been decided to close the works at Little-road, in order to concentrate the the business at Chelmsford. Last year the orders from Sydney had appeared satisfactory, but it had since been discovered that the contracts which had been made were unsatisfactory, for the payments were to be made by instalments The Australian company had come to grief, and the realisation of assets might take some time, but it was hoped that the debenture-holders (who included this Company) and the secured creditors would be paid. It had been considered advisable for Mr. Albright to start for Australia that night, with the view to looking after contracts there. The arc lamp department continued to show excellent results. The Company would continue to have the services of Mr. Crompton and Mr. Albright as managing directors. He believed that the future of the Company promised considerable improvement.

Mr. R. E. Crompton, in seconding the motion, said that there had been enough of prophesying, and all he would say was that they would do their level best to get things round. An improvement had sprung up six months ago.

Mr. Evans thought that more should be written off various items of the assets.

Mr. Kitchen considered the sum under trade debtors to be enormous, and had been told that the Company were the worst firm in London for cutting prices. He was of opinion that they were overtrading at low prices.

Mr. Crompton said that it was very difficult for any firm to get profitable contracts unless they took financial risks, and in all ordinary cases the profit was very small indeed.

Viscount Emlyn stated that 10 per cent. was written off the patents account every year. The goodwill was put down at a very fair figure. The £1,000 received from the French Company would come into next year's accounts. They were obliged to keep down prices, or they would have no business at all.

The motion having been adopted, Mr. Bernard Gibson was re-elected a director, and Messrs. J. H. Duncan and Co. were reappointed auditors.

Viscount Emlyn stated that having been elected chairman of the Great Western Railway Company, he found he had so much work on his hands that he would have to resign the chairmanship of the Company.

MANCHESTER EDISON-SWAN COMPANY, LIMITED.

The thirteenth ordinary general meeting of this Company was held on Thursday last at the Company's works, Broadheath, Mr. V. K. Armitage, the chairman, presiding.

The report and balance-sheet for the year ending May 31 showed that the net profit, including last year's balance, amounted to £1,590, which it was proposed to appropriate as follows: To payment of dividend at 5 per cent. per annum, £1,303; balance to be carried forward, £287.

The **Chairman**, in moving the adoption of the report and balance sheet, said that the document was one which they submitted with a considerable amount of satisfaction. Although the last 12 months had been a period of very great trade depression, as the shareholders were aware, the Company were still able to return to what prior to last year was their ordinary course, and to recommend a 5 per cent. dividend, which he considered a very satisfactory state of affairs. Their gross profits had been £5,877, as against £5,200 in the previous year, and the net profit £1,590, as against £1,334 last year. In addition to that they had taken off as depreciation £591, as against £226 last year, so that they showed a trade improvement of £614 over the trade of 1894. The directors attributed that almost entirely to the additional work they had got in the Altrincham lighting station, which the shareholders had just had an opportunity of looking through. The directors had no doubt that in the future they would find a very great advantage from their connection with the Altrincham and Bowdon Company, and from the increased facilities they had in their Broadheath manufacturing works. Since the end of May last they had obtained additional orders to the amount of £73,000, which he considered very satisfactory.

Mr. W. P. J. Fawcus, the managing director, seconded the motion, and gave details as to the increasing work which was being done by the Company.

The resolution was passed.

The **Chairman** moved a resolution declaring a dividend of 5 per cent., the surplus of the profit to be carried forward.

Mr. F. B. Ross seconded the motion, which was adopted.

Mr. V. K. Armitage, the retiring director, was re-elected, and the auditors, Messrs. Jones, Crewdson, and Youatt, were also reappointed.

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LIVERPOOL OVERHEAD RAILWAY COMPANY.

The half-yearly meeting of the shareholders of this Company was held on Tuesday in Liverpool, Sir W. B. Forwood, chairman of the board of directors, presiding.

Sir W. B. Forwood, in moving the adoption of the report and statements of accounts for the half-year ending June 30 said they were of a satisfactory and encouraging nature. Their traffic for the first six months had always in their experience been considerably less than that of the second half-year. The reason was this: in the first half-year they had to depend almost entirely upon what he might call business traffic alone, except during the period of Whit week when they had some additional holiday traffic. In the second half-year they got most part of their holiday and excursion traffic. Therefore they compared their figures with those for the corresponding period of last year. They would notice that their number of passengers had increased from 2,861 437 to 3 460,060 in the past half year. Looking at these figures a little more in detail, he thought they would find that there had been a very satisfactory increase in the number of first-class passengers. The number had increased from 277,653 to 400,260 and there had also been a very satisfactory increase in the number of second-class passengers The number had gone up from 1,246,975 to 2 114,462 Their gross receipts amounted to £28,082, against £20 011 in the corresponding half of last year, showing an increase of £8,071. The gross expenditure had been £18,658, as against £14.947, or an increase of £3,711; that was to say, they had earned an increased revenue of £8,071, of which they had spent in earning it £3,711, but part of that expense had gone in the increased mileage. The increase in the running was 46,000 miles, and they had worked 16 stations instead of 14, consequently, they had had the additional expense of two stations. He was glad to say their traffic had continued to progress since those accounts were made up. During the six weeks which had elapsed since June 30 they had increased their traffic by 55,000 passengers, and had taken £1,568 more money than they did during the corresponding six weeks of last year. The net available profit for dividend was £8,076, and they proposed to declare a 5 per cent. dividend upon their preference capital, and also a dividend at the rate of 2¼ per cent. on the ordinary shares, leaving a balance of £1,302 to be carried forward to the next half-year. Looking at the accounts a little more in detail, he found that their receipts for passengers had averaged 1 92d. per passenger, as against 1 65d. This increase, which meant nearly one third of a penny per passenger, was due to the advance they had made in the workmen's tickets and to the increased first class traffic upon the line. The ratio of expenditure to their revenue had been 66 43 per cent., as compared with 74 69 for same half of last year. The ratio of the cost of their locomotive expenditure to net revenue was 24 26d., as against 21·28d. That was an increase of nearly 3d. This was due to their having had more repairs to effect to their motors than they had at the similar period last year, the long frosty winter being particularly trying to their motors. The proportion of their travelling expenses to their revenue was 37·54d., as against 41·99. That was also a satisfactory feature, as showing that in proportion to their revenue their expenses had gone down. Their revenue per train mile had increased from 18·10d. to 21·65d.—that was to say, they had increased their revenue per train mile 3·55d. per cent. The expenditure per train mile had gone up from 2 88 to 3·49, an increase of 0 61d. While their revenue had increased 3·55d., their expenses had increased only 0·61 per train mile. In reference to the physical condition of their structure, it had never been in a better condition than it was at this moment. With respect to the Southern extension, that was to say, the extension from the Herculaneum Dock, the present terminus, to a point in Park-road near the Dingle, they had let the contract at a figure within the estimate made by their engineers, and he might say that the contractors were already very busy at work. The directors had every reason to anticipate that this new extension would be completed within the time stated in the contract—namely, 12 months.

Mr. James Barrow seconded the motion, which was agreed to without discussion.

The **Chairman** next moved that a dividend be declared of 5 per cent. per annum on the preference shares, absorbing £2,529. 0s. 9d, and of 2¼ per cent. on the ordinary shares, amounting to £4 244 17s. 9d., and that the balance of £1,302. 18s. 11d. be carried forward to next half-year's account.

This was also seconded by **Mr. Barrow**, and carried.

BRISTOL TRAMWAYS AND CARRIAGE COMPANY, LIMITED.

The half-yearly meeting of this Company has been held at Bristol, Mr W. Butler occupying the chair.

The **Chairman**, in moving the adoption of the report and accounts, said that during the last six months they had had much anxious work in connection with the construction of the electric line to Kingswood. The permanent way was finished, and the overhead construction was nearly completed. The power station was in an advanced state; the boilers and two of the three engines were in place, whilst the dynamos were also fixed. The trucks and motors were all in the station being fitted together, and the car bodies were practically completely and would be delivered in about a fortnight. The directors anticipated that a very few weeks will see everything ready for work. He believed that they would have one of the most complete electrical installations ever constructed.

The motion was adopted.

IMPERIAL TRAMWAYS COMPANY, LIMITED.

The report of the directors to June 30 last states that compared with the first half-year of 1894 the gross receipts of the Corris Railway show a slight falling off in the goods department, consequent upon the enforced idleness of some of the slate quarries during the exceptionally dry season. The expenses are approximately the same, and the net profit enables a dividend of 5 per cent. per annum to be paid, after meeting the interest on the Company's debenture stock. The working of the Dublin Southern District tramways during the past six months will not be expected to afford any proper comparison with the corresponding period of previous years, inasmuch as the traffic has been seriously disorganised by the electrical reconstruction works in progress. It will be observed that the net deficiency on the working of the undertaking amounts to £395, and has been charged against the Imperial Company's reserve fund. The permanent way reconstruction and electrical equipment of the lines between Dublin and Kingstown are well advanced, and traffic on the Dalkey section will shortly be discontinued to allow of that also being taken in hand. The receipts from the Middlesbrough tramways again show a satisfactory improvement, whilst the expenses of that department compare favourably. The working of the river steamers, however, has proved somewhat disappointing, the receipts exhibiting a small decrease and the outlay having been rendered greater than usual in consequence of extensive repairs. The gross receipts of the Reading Tramways have been well maintained, and compare very closely with those of the corresponding half-year. On the other hand, the expenditure has been £135 less, so that there remains an available balance of £809, sufficient to allow of a dividend of 6¾ per cent. per annum, as against 5½ per cent. in the same period of 1894. The receipts from the several undertakings give a gross revenue of £1,268, reduced by the usual expenses to £1,229. To this amount has to be added the balance brought forward from last account of £719, making £1,949 for disposal. Interest already paid upon the Company's 4½ per cent. debentures has absorbed £458, and the directors propose that the remaining sum shall be appropriated in the payment of the dividend on the 6 per cent. preference shares, for dividend at the rate of 1½ per cent. per annum on the ordinary capital, and to carry forward £341.

BIRMINGHAM CENTRAL TRAMWAYS COMPANY, LIMITED.

The report of this Company for the past half-year states that the reduction of the nominal amount of the ordinary capital of the Company from £10 to £5 per share authorised by the shareholders has been sanctioned by the court. The working profit for the past year amounts to £55,924. 0s. 11d., against £52,804. 8s. 11d. for the year ended June 30, 1894, or an increase of £3,119. 12s. The deductions from the working profits of the year have been very heavy, and the amount available for reserve and dividend amounts to £21,491. 19s. 9d. The directors recommend a dividend of 3 per cent. upon the ordinary shares. The report adds: "The working account shows that the earnings of the steam trams amounted to £83,699, on 1,273,342 miles run, and 15,841,584 passengers carried. The expenses were £48,348, or 9s. 11d. per mile, and the net profit of the section £35,351. The horse department earned £27,888, of which £22,056 was taken by the omnibuses. The 'buses ran 552,164 miles, and carried 2,973,983 fares; and the horse cars ran 152,895 miles, carried 1,320,344 passengers, and earned £5,165. The outgoings of the department were £25,494, or 8 67d. per mile run, and the profit £2,394. The cable section earned £36,744, ran 743,805 miles, and carried 6,842,538 passengers. The working expenses were £16,830, considerably less than half the receipts, and equal to 5·43d. per mile, against 8 67d. in the horse section, and 9·11d. for steam. The electric section shows up worst. The traffic, etc., receipts on 138,925 miles run and 1,154,345 passengers carried, were £9,093, and the expenses £10,828, equal to 18·43d. per mile, entailing a deficit on the section of £1,735. Deducting this amount from the profits earned by the other sections, the net balance of earnings comes out at £55,924,"

BELFAST STREET TRAMWAYS COMPANY.

The forty-sixth ordinary half-yearly meeting of this Company was held on Tuesday in Belfast, Mr. W. M. Murphy being in the chair.

The **Chairman**, in moving the adoption of the report and accounts, said that in connection with the matter of meeting public requirements the question cropped up of mechanical traction. This was creating great attention now both in the United Kingdom and abroad. In the United Kingdom, owing to the conditions under which the tramway concessions were held, this question was rather behind what it was in the rest of the world. In the United States, out of a total of some 14,000 miles of street tramways, there were over 10,000 worked by electricity. In the Continent of Europe, and especially in Germany, through which he travelled last year, electricity was fast taking the place of horse-power, and he believed in 20 years the horse tramway would be a curiosity. Something had been said about the danger of mechanical tramways, but he might mention a fact in this connection which came under his notice in the last few months. The Dublin Tramways Company were promoting a Bill in Parliament to enable them to work their system by electricity instead of horse-power, and one of the questions raised in the House of Commons was the alleged danger of electrical lines to the public. They had the evidence of the engineer of the Walsall Company, whose lines had been worked

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by electricity, and that gentleman told them that the company had insured itself against accidents to persons, and that the insurance company were in favour of the electrical system. One ounce of fact like that was worth a ton of theory, and it proved that electrical tramways were not more dangerous to the public than horse-power. In point of convenience, also, electrical cars had the advantage. The Belfast Street Tramways Company only having a lease of the lines for 12 years, it would be utterly impossible for them to attempt the large expenditure which would be necessarily incurred in adopting the electrical system. They had expressed, however, to the Lord Mayor and town clerk their willingness at any time the public demanded the change, to take it into consideration and discuss the matter with the Corporation. The Corporation at present did not think it desirable to move in the matter, but as far as the Company were concerned they were open at any time to receive suggestions or proposals on the subject if the feeling of the public was in favour of this system of traction. The people of this country did not know much of it, but as soon as they had experienced the benefits of an electrical system he believed they would demand it.

Mr. Fry seconded the motion, which was carried.

Mr. R. Johnston (shareholder) enquired which of the two systems—horse and electricity—was the cheapest to work, and the

Chairman, in reply, said experience had shown that the electrical system was cheaper than horse-power. Mechanical traction produced improved speed, and the receipts were thereby enormously increased.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Genoa.—The Royal Arsenal Authorities in Genoa invite tenders by August 21 for the supply of 6,800 kilogrammes of half-round copper wire. Estimate, 11,900 lires. Security, 1,190 lires.

Torrevieja.—Tenders are invited by August 20 by the municipal authorities of Torrevieja, Alicante, Spain, for the concession of the electric lighting of the town. The annual rental named is 4,000 pesetas for 100 16-c.p. incandescent and three 400-c.p. arc lamps.

Alexandria.—The municipal authorities of Alexandria, Egypt, invite applications by October 1, 1895, for the concession of the tramway lines from St. Catherine Place, through the outer boulevards, to the projected abattoirs at Mex, with a branch line. Security £E1,000.

Selby.—The Selby Urban District Council are prepared to receive tenders for the erection of three lightning conductors for the water tower and engine chimney at the waterworks, Selby. Full particulars can be obtained from Mr. W. Curry, surveyor, Town Hall, Selby. Tenders must be received not later than the 19th inst., endorsed "Lightning Conductors."

Braila.—The Municipal Authorities of Braila, Roumania, invite tenders by October 2 for the construction and working of a system of electric tramways in the city. Provisional security, 10,000f. This contract was originally fixed for July 29. Tenders are further invited by the Municipal Authorities of Braila for the lighting of the city by electricity or by electricity and gas. Provisional security 10,000f.

Cowes.—Tenders are invited by the Urban District Council for laying down an electrical plant of sufficient capacity to keep burning at the same time 2,200 8 c.p. lamps, and also for public lighting and the laying of mains to accommodate 3,000 lights at the same time. The length of the road to be lighted is about a mile. Particulars can be obtained from Mr. Nelson F. Dennis, A.M.I.C.E., engineer to the Council, Cowes. Tenders are to be delivered by August 27.

Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

London, W.—The Hammersmith Vestry invite tenders for complete schemes for public and private lighting, and for the supply of motor power in that portion of the parish of Hammersmith described in the provisional order as the compulsory area. Memoranda of instructions, with a map of the district, may be obtained from Mr. H. Mair, surveyor to the Vestry, between the hours of nine and five, Saturdays nine and one, on payment of a deposit of £10, which will be returned to persons sending in a bona fide tender. Tenders are to be delivered at the meeting of the Vestry, at the Vestry Hall, at 6.30 p.m. on September 4.

Killarney.—The Commissioners for the Control of Lunatic Asylums, Custom House, Dublin, invite tenders for the electric wiring of the Killarney District Lunatic Asylum, the same to be connected to the supply mains (high tension) of the Killarney Electric Lighting Company. Forms of tender will be issued on application to the above Commissioners on deposit of £1, which will be returned to all persons who have sent in *bonâ fide* tenders on return of specification. The plans and specification can be seen at the asylum or at the office of the engineer, W. Leake, Esq., 30, Victoria-buildings, Manchester. Tenders are to be sent in by 30th inst.

Sunderland.—The Corporation invite tenders for (*a*) high-tension and low-tension concentric cables; (*b*) cast-iron pipes and box frames and covers; (*c*) stoneware casing, boxes, and bell-mouth protectors; (*d*) high tension transformers for alternating current; (*e*) meters for alternating current. Specification, etc., can be obtained on payment of one guinea at the office of the borough electrical engineer, Electric Supply Station, Sunderland. The deposit will be refunded on receipt of the specification and conditions of contract with a *bonâ fide* tender. Tenders should be delivered at the town clerk's office by Monday, 26th inst.

Portsmouth.—Tenders are invited for wiring and lighting by electricity the police stations at Buckland, Southsea, Portsmouth, and Portsea Full particulars can be obtained, and specifications can be seen, at the Town Hall, where a form of tender can also be obtained. Form of tender supplied to be completely filled in and sent under cover to Mr. Alexander Hellard, town clerk, by 3 p m. on 27th inst. Form of tender must include a declaration that the person making the tender pays not less than the trade union rate of wages, and observes the hours of labour and conditions recognised and in practice obtained by the trade unionists in the borough.

Islington—The Vestry are open to receive tenders for the wiring of the Vestry Hall and municipal offices in Upper street, N., and for the supply of fittings. Specification, etc, can be obtained on application to the electrical engineer, Electricity Department, 50, Eden-grove, Holloway, N. Deposit of £1. 1s. will be required for the forms, but such deposit will be returned on receipt of a *bonâ fide* tender. The contractor whose tender is accepted will be required to pay his employés engaged on the work the trades' union rate of wages and observe trades' union conditions and hours of labour. He will also be required to enter into a contract and to find two sureties for the due execution of the work. Tenders must be sent in by 27th inst

Wakefield.—The Corporation invite tenders for the supply and erection of the following: Section A—boiler-house plant (boilers and fittings, mechanical stokers and engine economiser, feed-pump, injector, etc.); Section B—engine-house plant (steam alternators condensers, oil filter, fittings, etc., steam, exhaust, feed, blow-off, and sundry pipes, valves, and water-tank, etc.); Section C—main switchboard and instruments; Section D—underground work (cables, junction-boxes, culverts, and trenching, etc.); Section E—sub-station fittings (transformers and switchboard, etc.); Section F—arc lamps and posts; Section G—meters; and Section H—overhead crane. Particulars are obtainable from Mr. Robert Hammond, Ormond House, Great Trinity-lane, E.C., on payment of £2. 2s, which will be returned on receipt of a bona fide tender. Tenders are to be delivered by August 24.

RESULTS OF TENDERS.

Bradford.—The Town Council have accepted the tender of Mr. G. A. Steinthal for the supply of two switchboards for the central electric light station for £185.

BUSINESS NOTES.

Great Northern Telegraph Company.—For the month of July the receipts were £25,600.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,725.

Hereford—The National Telephone Company have decided to open a telephone exchange in Hereford.

Lanchester.—The Board of Guardians have decided not to adopt the electric light for the new infirmary.

Lytham—A start has been made with the construction of an electric tramway between Lytham and Blackpool.

Brompton.—The annual report of the Brompton Consumption Hospital states that the committee have decided to light the whole of the hospital by electricity.

Installation Work.—The Tayler-Smith Electric Company, Limited, are carrying out the installation of 6, Roland Houses, for Admiral Sir Windham Hornby, K.C.B.

Buxton.—Letters from the Welsbach Incandescent Electric Lighting Company and from the City of London Electric Lighting Company have been referred to a committee by the Urban District Council.

Rugeley.—The District Council have been discussing the question of lighting the town, and Mr. Seabrook, a member, suggested that they should utilise water power for electric lighting purposes.

Agency.—Messrs. Hodges and Todd, Hampstead-road, London, have appointed Messrs. W. McGeoch and Co., Glasgow, who will keep a stock of their electrical instruments, their sole agents for Scotland.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 11th inst. amounted to £1,578, as compared with £1,257 in the corresponding week of last year, being an increase of £321.

Change of Address.—Messrs. Russell and Lennard, electrical engineers and contractors, late of 22, Charing-cross, inform us that owing to pressure of work they have removed their offices to more commodious premises at 135, Victoria-street, Westminster.

Stafford.—In connection with the new electric supply station, the Town Council have appointed Mr. J. S. Highfield, of Clifton, Manchester, electrical engineer, at a salary of £120, and Mr. Dawson Clothier, assistant electrician, at a salary of £80 a year.

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Aberdeen.—The electrical engineering business carried on by Messrs. New and Mayne, at 6, Schoolhill, Aberdeen, has been taken over by Messrs. P. C. Middleton and Co. Mr. Middleton was manager for Messrs. New and Mayne during the past two years.

Bournemouth.—The Winter Gardens Committee of the Town Council have recommended that in the lighting of the pavilion the large 500-c.p. lamps be removed and 16 c.p. lamps in groups of 18 lamps each be substituted. The recommendation has been approved.

Brighton and Rottingdean Seashore Electric Tramroad Company.—An extraordinary meeting of shareholders of this Company will be held at the offices, Madeira road, Brighton, on Friday, August 30, at 4 p.m., for the purpose of considering the issue of debentures and adopting a resolution thereon.

City and South London Railway.—The returns for the week ended August 11 were £860, compared with £897 for the corresponding period of 1894, being a decrease of £37. The total receipts for the half-year 1895 are £5,084, as compared with £5,203 for the corresponding period of 1894, being a decrease of £119.

Interruptions to Cables and Landline.—The following interruptions have taken place: cable, Brest-St. Pierre, Anglo-American Company, April 6, 1893; cable, Accra-Kotonon, August 12, 1895; cable, Accra-Lagos, August 12, 1895; and landline, Saigon-Bangkok, August 12, 1895. No repairs have yet been effected.

Bristol.—The Bristol Docks Committee held a meeting on Monday, when it was resolved, on the recommendation of the Sub-Committee for Works, to erect a signalling station near Sea Mills, for the purpose of facilitating navigation during fog, and to provide telephonic communication between such signalling station and the labourmaster's and dockmaster's offices.

Private House-Lighting.—Messrs. Rashleigh Phipps and Co. have recently received instructions to carry out the electric lighting of Lord Dudley's new house, 7, Carlton-gardens, and we understand, moreover, that they are at the present time exceptionally busy with the installation of a large number of private houses, etc., in the West-end of London and elsewhere.

Belfast.—The Electric Committee of the Corporation have met under the presidency of Alderman Sir Daniel Dixon. The resident engineer reported that the establishment under his control was in satisfactory working order. He also reported on the tenders for inspection plugs, referred to him at last meeting. Messrs. Richard Patterson and Sons' tender being the lowest, it was accepted.

Outing.—The employés of Messrs. Rashleigh Phipps and Co. had their annual outing on Saturday, 27th ult The party, comprising almost the whole of the staff, proceeded by an early train to Ramsgate, where they dined at the Cannon Inn. After dinner an interesting drive through Pegwell, Birchington, Margate, etc., was enjoyed, the proceedings throughout being characterised by great enthusiasm.

Phœbus Electric Battery Syndicate Limited.—This company has been registered by Mr. E. Pellas, Broad-street-avenue, E.C., with a capital of £3,000 to adopt an undetailed agreement for the acquisition of certain inventions in relation to primary batteries, and to carry on the general business of electrical and mechanical engineers, electricians, etc. Registered without articles of association.

Burton-on-Trent.—A meeting of the Town Council has been held, at which it appeared from the minutes of the Town Hall Committee that the report of the accountant on the examination of Mr. Churchill's account relating to the furnishing and electric light installation done jointly between Lord Burton and the Corporation showed there had been an excess of expenditure over the loan sanctioned of £259. 17s. 6d.

Meltham.—A meeting of the Urban District Council has been held, at which Mr. Allen Hollingworth, agent for Messrs. Jonas Brook and Bros. waited upon the Council and requested them to put down a new 2in. gas main to Meltham Hall, and also that the Council supply an adequate meter of from 80 to 100 lights. The gas, it transpired, was required to drive engines in connection with electric lighting machinery at the hall. The 2in. main and meter were granted.

Halifax.—At Monday's meeting of the Town Council, upon a resolution, moved by Alderman Brook, to authorise the expenditure of £1,000 for the purpose of supplying electric light to the district of Skircoat, Alderman Whitaker asked if the Council had had a sufficient number of applications from that district. Alderman Brook replied that they had applications from about 500 persons. He also explained that the proposed supply would not go further west than Heath-villas.

Snaefell Electric Railway.—It was expected that the new line of electric railway to the summit of Snaefell would have been opened for traffic on Saturday last, but in consequence of the delay which has taken place in erecting the overhead wires which supply the current, through the unfavourable weather of the last two weeks, the line will not be available for traffic before to-morrow (Saturday). The Board of Trade inspection by Colonel Rich and Major Cardew takes place to-day.

Cheltenham.—The Corporation are about to apply to the Local Government Board for sanction to a further loan of £10,000 for extension of mains and provision of additional machinery to meet the increasing demands for the energy. Three months ago there were 27 applications on the books, now there are 57. Some 2,160 8-c.p. lamps are already connected, and other applications in and coming in will bring the total up to over 3,000 lamps. The question of street lighting by electricity is under consideration.

Partnership.—Mr. G. L. Addenbrooke informs us that he has taken Mr. Ernest Scott into partnership. Mr. Scott served his time with Messrs. John Fowler and Co., Leeds, and was afterwards with Messrs. W. T. Goolden and Co., and the Brush Company, while for the last year he has been chief of the drawing-office department at the Electric Construction Company's works. Letters to the firm should be addressed to 21, Lichfield-street, Wolverhampton, but Mr. Addenbrooke will be frequently in London as heretofore.

Morecambe.—An extraordinary general meeting of the shareholders of the Morecambe Electric Light and Power Company, Limited, was held on Saturday evening to receive and consider a statement of the Company's affairs prepared by the secretary. After this had been discussed, it was resolved unanimously that the directors be empowered to treat with and enter into a binding agreement with the Morecambe Urban District Council, or any other intending purchaser, for the purchase and transfer of the Company's undertaking and property on the most favourable terms.

Keighley Electrical Engineering Company, Limited.—This Company has been registered, with a capital of £5,000, to acquire and take over as a going concern the business of the Keighley Electrical Engineering Company, Limited, of Bow-street, Keighley, to undertake all or any of the liabilities of the said Company on the terms and conditions set forth in the proposals in writing made for the old company by Arthur D. Smith, its secretary, and to carry on the business of electrical engineers, electrical suppliers of electricity, and manufacturers of and dealers in electrical apparatus.

Polyphase Currents.—Messrs. Johnson and Phillips have in hand the plans for another transmission scheme for the Barberton district. The power will be delivered by diphase currents at a distance of five miles from the power station, at which water power will be utilised to the amount of 120 h.p. The difference of potential at the generator will be 3,000 volts. The plant is to be used for air compressers to work rock drills for prospecting. Messrs. Johnson and Phillips have also in hand the St. Helens alternator, the alternators for the Cape Town and suburban lighting, the transformers for the Portsmouth extensions, and the transformers for the Bedford extensions.

Telephone Service for the West Riding Police.—The West Riding Standing Joint Committee have adopted the recommendation of the sub-committee to pay the National Telephone Company, Limited, £1,300 per annum for a private service of telephones for the purposes of the West Riding Constabulary, the materials and plant to belong to the company at the end of 15 years. At the end of that period the company will not object to renew the agreement for another 15 years on terms to be agreed upon for an annual sum to be paid to cover the actual maintenance, and they agree to the County Council extending the system to other police buildings than the divisional headquarters and the principal sectional stations named in the scheme.

Middlesbrough.—The Mayor (Alderman W. L. Taylor) presided at Tuesday's meeting of the Middlesbrough Council, when the Electric Lighting Committee minutes, which came up for adoption, recommended that a specialist be engaged, at a cost of not more than £50, to consider and advise the Corporation as to the best and most economical method of laying down electric light plant. Alderman Bulmer thought they should spend no more of the ratepayers' money, at all events at present. They had at present to meet a million and a half debt to pay interest and redemption on, and they should not further saddle the ratepayers. He moved that the minute be struck out. Alderman Sanderson seconded. After some discussion the minutes were adopted in their entirety.

Plymouth.—At Monday's meeting of the Town Council Mr. Bray, in moving the adoption of the Tramway Committee's report, commented upon the steady increase in the business done. Mr. Debnam reminded the Council that the Corporation of Portsmouth had decided to send a deputation to Bristol to inspect the electrical tramway works there, and asked whether it would not be advisable for that Council to adopt a similar course. Mr. Bray said they had received a communication from the contractor at Bristol, and he proposed to ask that a deputation from Plymouth might be sent to inspect the work. They, as a committee, before doing any work in Ebrington-street, should very seriously consider the advisability of adopting electrical power for a portion of their service.

Ipswich.—The Town Council have decided to experiment with incandescent gas burners for street-lighting. In the discussion on the subject, Mr. A. Cattermole elicited the fact that a contract for three years was to be entered into with the gas company, and urged that it would be more prudent to postpone the signing of such a contract until the Paving and Lighting Committee had reported upon the application which had been made for a provisional order by an electric lighting company. He moved as an amendment, therefore, that the consideration of this clause should stand over to the next meeting. The amendment was not seconded, and, in the course of conversation upon the matter, the town clerk pointed out that nothing could probably be done with regard to electric lighting, which would affect the public lighting of the town within the next three years.

Coventry.—A quarterly meeting of the City Council was held on Tuesday, the Mayor (Alderman Loudon) presiding. The Electric Light Committee recommended that rebates should be allowed to those consumers whose accounts are the most profitable to the

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undertaking; the full price of 6d. per unit to be charged for all energy consumed in a half year up to a total equivalent to two hours' use per day of the maximum demand, and that all energy consumed beyond that total be charged at 3½d. per unit. Mr. Andrews opposed the recommendation, thinking that the true policy would be to charge a sufficiently high price to begin with, and then reduce the charge if found desirable. In the discussion it was stated that the plan had been found to prove remarkably successful at Brighton and elsewhere. The report was adopted.

Folkestone.—A Dover paper states that if the Dover Electric Light Company can make terms, as they propose, with the Corporation of Folkestone to supply them with the electric light, it will no doubt be an economical way of supplying that town, and will also be a good thing for our local company and for Dover generally. The Dover Electric Light Company have erected a station large enough to supply the whole of Dover, but, as a matter of course, with gas and other illuminants to compete with, they cannot expect to fully utilise their resources for several years, therefore it will be an improvement to Dover as a commercial centre for Folkestone to take their light from the Park-street station. Folkestone as a go ahead visitors' resort certainly needs the light, and it is clear that they could not obtain it at so little outlay in any other way.

Erdington.—A meeting of the Urban District Council has been held at which Mr. Dawson, a member, stated that since the last meeting he had made enquiries with respect to telephonic communication being established between Erdington and Aston. It would be remembered that an offer was accepted from the National Telephone Company to establish the communication at a charge of £25 per annum. He had interviewed Mr. Whitehouse, electrician, upon the subject, and had ascertained that it was possible to obtain telephonic communication of their own for about £50 and the charge for wayleave would only amount to £5 or £7 per annum. Mr. Whitehouse was prepared to submit a complete estimate of the cost of such communication to the Council at their next meeting. The Chairman said the Council and ratepayers were greatly indebted to Mr. Dawson for the trouble he had taken in the matter, and he moved that Mr. Whitehouse be asked to prepare an estimate. This was agreed to.

Blackpool.—A meeting of the Town Council has been held, at which the following minutes of the Electric Lighting and Tramways Committee were confirmed: July 23—Read, the following resolution of the Highway Committee on June 20, 1895: "That in view of probable future extensions of the Corporation's electricity works, all the central store-yard land between West Caroline-street and Princess-street, in this committee's department, be transferred to the electric lighting department on terms to be arranged." Resolved, that the Corporation be insured in the Law Accident and Contingency Insurance Society, Limited, against accidents from tramway cars and the permanent way of the tramways in the sums mentioned in the draft policy now submitted. July 25: That a sub-committee, consisting of the mayor, the chairman (Councillor Pearson), Aldermen Buckley and Bickerstaffe, and Councillors Heap and Smith, be desired to consider and report upon the best means of working electrically the Lytham-road tramways south of Station-road."

Cardiff.—A meeting of the Borough Council was held on Monday, when Councillor F. J. Beavan directed attention to the electric lighting account, which showed an expenditure of £5,053 in excess of the estimate, and pointed out that it was proposed to borrow £7,000. What, he asked, was to be done with the difference of nearly £2,000? It was explained that the added amount was for purchase of meters, extending mains, etc., and other requirements, the Mayor admitting that a statement to this effect ought to have appeared in the minutes.—At a ball given in honour of the "coming out" of Miss Edith Gibbons, eldest daughter of Mr. J. Skipworth Gibbons, of Boddington Manor, great satisfaction was given in the lighting arrangements of the grounds, conservatory, ball and supper rooms, etc., all of which had been carried out by Messrs. Knapman, Hodder, and Co, electrical engineers, Cardiff. For this purpose a dynamo, portable engine, and the necessary equipments had been brought into requisition.

Perth.—A meeting of the Town Council has been held, at which the town clerk submitted a letter he had received from the Caledonian Electric Supply Company, Glasgow, giving notice—in terms of the Electric Lighting Acts, 1882-88—of their intention to apply for a provisional order for the electric lighting of the burgh. The company hoped that the Corporation would be favourable to giving an opportunity of laying before them the terms they were prepared to offer. He (the town clerk) had replied, pointing out that the company had been too late in sending their intimation, which, in conformity with the Act, should have been made by July 1, and they had not answered his letter. On previous occasions the Town Council had disapproved of proposals to light the city by electricity, but probably it would only be courteous to allow the company an opportunity of lodging their terms. This would not, of course, preclude the Council from making objection to the application for a provisional order on the ground that timeous notice had not been given. The town clerk's suggestion was agreed on.

Machinery Insurance.—The Machinery Insurance Company, Limited, with a capital of £200,000 in 195,000 ordinary shares and 5,000 deferred shares of £1 each, has been formed to develop a system of insurance of machinery against partial or entire breakdown. The directors, at the outset, propose to confine the business to machinery alone, believing that in this department there is a well-nigh exhaustless field ready to their hands. A contract has been entered into with Mr. James Robert Fawkner, as vendor, whereby in consideration of the transfer to the company of the business of machinery insurance and maintenance, heretofore carried on by him, together with the goodwill, trade connections, policies in force, etc., the company agrees to pay to him the sum of £3,500 in cash, and to allot to him, or his nominees, 2,000 ordinary shares and 2,000 deferred shares of £1 each fully paid. The present issue is of 95,000 ordinary and 5,000 deferred shares. In Prof. Kennedy, F.R.S., president of the Institution of Mechanical Engineers, who has accepted the office of consulting engineer, the company will have at its command the advice and assistance of one of the first authorities in the science of mechanical engineering.

Colchester.—At the last meeting of the Town Council the Lighting Committee reported that the consulting engineer, Mr. W. H. Massey, had applied for a payment on account for his professional services, and the committee recommended that a payment of 30 guineas be made to him. Mr. Smith moved the adoption of the report. He said the committee were very anxious before coming to the Council with any scheme to thoroughly look into every suggestion that had been made as to lighting the town. They had had several conferences with and reports from Mr. Massey, who was still advising them, and the committee were unanimous in recommending this payment on account. Mr. Penney seconded. Mr. Beard said he noticed this was merely a payment on account. How far did the committee intend to go? Was there any particular amount specified, or was Mr. Massey "going to any extent?" Mr. Smith replied that Mr. Massey was not going to "any extent." He was advising the committee, and they knew that up to the present time his fees were very reasonable. Of course, as a non-professional committee they were not able to advise themselves on this subject, but it was not their intention to incur any serious liability in the shape of fees, and he again assured the Council that up to the present Mr. Massey's fees were very reasonable. The report was adopted.

The Mersey Railway.—At the meeting of the shareholders of this Company, held on Thursday last week, Mr. A G. Kitching, the chairman, stated that it would be remembered that at the last meeting power was given to the directors to promote a Bill in Parliament to obtain permission to use electricity or any other motive power on their lines, and also in connection with a scheme for a settlement with the various classes of debenture stocks, to raise £50,000 more capital. The debenture stockholders did not agree with the scheme proposed in the Bill to raise the additional capital, and that part of it was dropped, and all that now remained of the Bill was that relating to electricity, and that part was in a state of suspended animation, and what the new Parliament would do with it the directors did not know. He regretted to say that the directors had not been able to come to an agreement with the debenture stockholders. The Act required that three-fourths of each class of debenture holders should give their consent to any rearrangement which might be come to, and so long as the great body of those holders would consent to nothing which did not advantage them it seemed to him that the directors could do nothing. He was not aware that the question of electricity had been settled; personally, he was not in favour of electricity, but there was no harm in having a Bill authorising them to use electricity as a means of locomotion, should the shareholders think fit to adopt it.

Music-Hall Lighting.—Collins's Music Hall, Islington green, has just been entirely redecorated, and amongst the many improvements which have been introduced that of lighting the hall by electricity stands foremost. This part of the work has been carried out entirely by Messrs. Vaughan and Brown, Limited, of 16, Kirby-street, Farringdon road, in 21 days from the date of commencement, the time for doing the work being of necessity very short, as it was imperative that the hall should reopen on Bank Holiday evening. The current was, we understand, promised by the Vestry for that date, but as their electricity supply works were not ready, the proprietor (Mr. Herbert Sprake) decided at the last moment to have a temporary plant laid down. Five days before the opening night, Messrs. Vaughan and Brown, Limited, undertook to supply and fix the plant and have it running on the night in question. This they succeeded in doing, having in the meantime put in a 65-h.p. engine and a large dynamo in a small space at the back of the hall. The electric light fittings are also supplied by the above firm. They were all specially designed for the hall, and manufactured at Messrs. Vaughan and Brown's works. The firm's search-light is worked from the roof of the theatre, and throws the rays of light down on the artists, producing a beautiful effect, and does away entirely with the lime-lights in the wings and the use of gas. We understand that the same firm are both lighting and heating, etc., the Bath Pavilion and the Bristol Empire, and also that they propose bringing out very shortly a new arc lamp.

Electric Clocks.—We have received a circular relative to the system of electric clocks which has been brought out by the Synochronome Company (F. Hope-Jones and G. B. Bowell), Birkenhead. Instead of a number of separate clocks requiring weekly attention, whose pendulums rarely even pretend to be accurate timekeepers, there is in this system but one pendulum which requires no attention and is capable of keeping time to within one second per month. It is usually placed in the hall, and the time it records is indicated by clock faces wherever desired. They may be placed on the mantle-shelves of the various rooms, or suspended on the walls with flexible cord, as the absence of mechanism enables them to be treated artistically, and suggests their combination with drawing-room art-work in wrought iron and wood carving. If desired, this simple electric movement can be

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fitted into any existing clock case, and striking or chiming may be accomplished by all or any of the dials. The necessary wiring is more simple than that for electric bells, being only the connection of one dial with another by a single line. For putting forward the hands of all the dials a push button is provided on one of them. For setting back it is sufficient to move the hands of this dial only, and all will be altered. When Government telegraph, telephone, or railway time signals are available the one pendulum may be automatically synchronised, and thus every dial will represent Greenwich mean time. The pendulum is kept in motion by two wheels and an electromagnet which derives its energy from a small dry cell.

Bangor (Wales).—A meeting of the City Council has been held, when the minutes of the meeting of the Electric Lighting Committee held on the 24th ult. were read. They stated that Mr. Medhurst was present and presented his amended report and estimate as to the proposed electric lighting works, which we give in another part of this issue. After duly considering same, it was proposed by Dr. H Grey Edwards, seconded by Mr. Robert Hughes, and unanimously resolved that the committee, having carefully considered the question of lighting the borough with the electric light and called to their aid Mr. Medhurst, electrical engineer, of Westminster, London, recommend the Town Council to apply for a license with the least possible delay, and that the committee be empowered to take whatever steps it may find necessary to carry out the scheme as suggested by Mr Medhurst in his report. Mr. Thomas Lewis, chairman of the committee, said he was sorry to say that the further he went into this matter the less inclined he felt to go on with it, and he therefore could not move the adoption of the minutes. Dr. H. Grey Edwards had great pleasure in moving the adoption of the minutes. Something must have occurred since the committee meeting to account for Mr. Thomas Lewis's astonishing action. Proceeding, Dr. Grey Edwards said that the committee had written to some 25 towns, some of which were corporations holding gasworks, for information as to the working of the electric light system in those places, and he thought that almost without exception they had received favourable replies. Mr. Robert Hughes seconded the motion. After some discussion, it was decided to refer the matter back to the committee.

Bradford.—At Tuesday's meeting of the Town Council, Mr. W. C. Dixon (chairman of the Gas and Electricity Supply Committee) moved the adoption of the minutes of that committee, which included resolutions approving the plan of a proposed extension of buildings at the south end of the electricity works, and accepting tenders for all the work amounting in the aggregate to the sum of £304. 13s 9d.; accepting the tender of Mr. G. A. Steinthal to supply two switchboards at the electricity works for the sum of £185; appointing Mr. Alfred H. Gibbings as electrical engineer at a salary of £300 per annum; advancing the salary of Mr. Dalton, assistant engineer in the electricity department, from £150 to £180 per annum; and accepting tenders for the supply of cannel and gas coal. Mr. Dixon said the extension referred to in the minutes was for the purpose of putting in two new boilers which could not possibly be got in, to allow any room for working, unless the enlargement of the premises took place. Mr. Dalton had been one of the applicants for the appointment of electrical engineer, and though the committee had not thought fit to appoint him they were satisfied that he was fully deserving of the increase of salary which was mentioned in the minutes. The resolution was seconded by Mr. James Kay. Mr. M. O'Flynn asked if the boilers which had been lately introduced into the works had given general satisfaction. Mr. Dixon said the new boilers referred to by Mr. O'Flynn were working so unsatisfactorily that the town clerk had had to threaten the firm who had provided them with proceedings if they did not at once put them into proper working order, so that they would fulfil the purpose for which they had been purchased. The minutes were adopted.

York.—A quarterly meeting of the York City Council was held on Monday night, the Lord Mayor (Alderman Wm. McKay) presiding. The Streets and Building Committee acting as the Electric Lighting Committee recommended the Council to accept the offer of the Electric Construction Company, Limited, for the supply of the first instalment of the plant, together with their offer to run the plant for a period of seven years. The tender is for the alternate-current system, and the essential points of the Oxford system are applied to alternating currents. Alderman Ager, in moving the adoption of the report, said the amount of the tender was £8,650, with an addition of £6,000 outlay for buildings, etc. The company offered to run the plant for a period of seven years, paying 6½ per cent. on the capital outlay, and agreeing to charge a sum of not more than 6d. per unit. The motion was seconded by Mr. Mann, who pointed out that the terms of the specification prevented any possibility of the scheme being a burden upon the ratepayers. The system would enable any part of the city to be supplied from one station, which it was proposed to build on the Foss Islands. Alderman Wragge though the system the Council was asked to adopt was the very worst that could possibly be proposed. Mr. Purnell maintained that the sanction of the Council was being asked to a scheme which the members of the committee did not understand themselves. He warned the Council against its adoption. Mr. Scott moved an amendment referring the matter back, with the object of taking the opinion of Prof. Kennedy as to the best system to adopt for the city; and the amendment was seconded by Mr. Mansfield and supported by Mr. Challenger. Mr. O'Connor having spoken in favour of the recommendation of the majority of the committee, Mr. Purnell argued that the various schemes which had been laid before the Council should have been considered as to economy and efficiency. The discussion was continued by Alderman Wragge, Mr. J. S. Grey, and Mr. Mann, after which the amendment was put to the vote, when only 3 voted in favour, 23 against, and 7 were neutral. The amendment was therefore lost. Alderman Wragge then moved as an amendment that the consideration of the matter be adjourned until the second Monday in October, but the amendment was negatived. Another amendment was proposed by Mr. Shafto to the effect that the matter be referred back to the committee, that they agree upon an expert who shall report as to the best mode of electrically lighting the city, advertise for tenders, and report to an early meeting of the Council. The amendment was carried.

Islington.—The Vestry have held a meeting at which the clerk reported a series of communications from the solicitor to the London County Council on the subject of the electric lighting loan of £51,000. It was agreed to accept the terms proposed by the Council, amongst which were the following: That the Vestry undertake not to raise during the currency of the loan any fresh amount to cover the same work; the rate of interest to be 2¾ per cent.; the loan to be spread over 42 years; and the Vestry to provide for all renewals during that period out of a sinking fund to be provided for the purpose. The amount estimated to be required for the purposes of the lighting rate is £9,032, an increase of £1,790 upon the current half-year's rate. The greater part of this addition is occasioned by the increased cost of lighting the public lamps in the "compulsory area" by electricity instead of gas. It is anticipated that the new system of lighting will come into operation about the middle of November next, the increase, therefore, covers a period of about 4½ months. A report was received from the General Purposes Committee stating that it had considered the question of the wiring and fitting up to the Vestry Hall and offices, for the purpose of lighting the same by electricity, and in connection therewith an estimate of the cost and a specification prepared by the electrical engineer; submitting such specification for the approval of the Vestry, and recommending that it be adopted; and that the committee be authorised to invite tenders upon the basis thereof, and to enter into a contract for the carrying out of the work at an estimated cost of £311 for the work set out in Schedule 1 of the specification; and at a further sum of not less than £20 for the work mentioned in Schedule 2, according to the design and workmanship decided upon as being most suitable. This was agreed to. A report was received from the Finance Committee stating that pursuant to Vestry reference of May 24 last, respecting the electric lighting loan of £51,000, it has submitted a case for the opinion of Sir Richard Webster, Q.C., and Mr. A. Macmorran, and they having advised that notwithstanding the provisions contained in Sections 190 and 191 of the Metropolis Management Act, 1855, the London County Council must be assumed to have a discretion as to the granting or otherwise of their sanction to a loan, the committee is of opinion that the Vestry should, under the circumstances, accept the alternative offer of the Council to lend the whole of the money for a mean period of 42 years on the condition that if any portion of the machinery or plant covered by this loan requires to be renewed during its currency, such renewal shall not be made the subject of a new loan, and on the further condition that the rate of interest be 2¾ per cent. per annum, and that the loan be taken up on the "annuity" principle, and recommended accordingly. This was agreed to.

Wigan.—A meeting of the Town Council has been held, at which Alderman Ackerley enquired if anything was being done with regard to the electric light. Mr. Holmes, the chairman of the Electric Lighting and Gas Committee, said he was afraid the electric light was snuffed out for a time. It was very much against his will. He thought the sub-committee were making a great mistake in the action they were taking, but he could not sit in judgment upon them. Unless they got the unanimous feeling of the sub committee he did not wish to proceed. If it were a question of a majority he had every reason to believe they could carry it, but he desired the whole committee to be in union and harmony. He hoped it might be soon. The committee might perhaps be taking the right course, but to him it did not appear to be so. Mr. Fyans thought that, notwithstanding that the small committee could not come to a unanimous verdict, the town or those directly interested in its institutions desired that the thing should be pushed forward. Look at the money they had spent in decorating that room, and at the free library with its priceless treasures, which would not only lose their lustre in a few years, but would get in a deteriorated state. Were they to understand that because one or two gentlemen on that sub-committee did not see eye to eye on the expediency of introducing the electric light, the Council were not to have the opportunity of casting their vote upon it? He said most unhesitatingly that the Council would unanimously support the action of the majority of the sub-committee. The introduction of the light might entail a little higher rate, but it would be of such an immense benefit to the local institutions, give facilities to tradesmen for advertising and making Wigan brighter and more important, so that it was worth the venture. If it was delayed much longer they would be giving other people the opportunities they possessed, and he promised that at the next meeting of the Council he would raise the question. Alderman Phillips said he knew there were important works of decoration waiting to be done, but the parties would not proceed because the electric light had been promised. When they saw the effect of the light in other towns, how it set off the shop windows, he felt they were behind hand, and he believed the chairman would have the support of the Council in carrying the work through. Mr. Johnson felt certain that if they delayed it

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much longer they would have private competitors. The matter should be pushed forward. He thought he knew why the chairman had not brought it on, but he should have another trial. Mr. Laycock felt sure it would come as a surprise and disappointment to manufacturers and business men that they were not as yet to have the electric light. He hoped the sub-committee and Gas Committee would take the matter in hand again, so that they could have in Wigan what was already common to most towns. Mr. C. B. Holmes' opinion was that the discussion must have the effect of giving the committee confidence to push forward with the matter. He could assure them that some three or four months ago they were anxious to proceed with the erection of the necessary buildings, so as to have them dry and in readiness for the reception of apparatus and engines.

Dublin.—A deputation representing the ratepayers residing in the neighbourhood of Earl-street waited on the Dublin Corporation on Monday to urge upon the Council the advisability of the Corporation granting the request of the tramway company to extend the electric tram system from Annesley Bridge to North Earl-street and Nelson's Pillar. Mr. Nagle strongly urged the prayer of the petitioners, and pointed out that all the inhabitants and frontagers along the line were most strongly in favour of the extension of the electric traction system. The deputation had the greatest possible confidence in the judgment of the members of the Council, and it would leave this question with the greatest confidence in the hands of the house. Mr. William Lawrence and Mr. V. O'Brien, as frontagers in O'Connell-street, supported the prayer of the petition. The Lord Mayor pointed out that the Corporation did not in the slightest degree oppose the introduction of the electric traction system. He himself was much in favour of it, but it should not be forgotten for a moment that the duty of the council was, whilst not opposing such an extension, to see that proper conditions should be imposed. They should ensure that proper and adequate conditions should be imposed—whether by way of rental for the benefit of the city, or whether by way of accurately defining the conditions under which the tramway company were to run their system. These were matters for future consideration. The tram company would appear to be desirous of erecting posts, wires, and everything they desired, and of practically taking possession of the streets to that extent. He was in favour of the electric tram system, and they should give the company every facility, which they were prepared to do. But within their own domain the Corporation were masters, and should not allow any other body to take control over their streets. There should be a clause in the Tramway Act providing that no system of electric tramways should be run without the consent of the Corporation. He believed that in this matter they would be supported by the Council and the citizens, and that they would not allow the tram company or any body to get further running powers or leave to erect poles, etc., without the absolute consent of the Council, and if the tramway company would introduce before the Lords the clause that the Corporation suggested, no doubt they would soon see the electric trams running in the streets the deputation spoke of. Mr. Little rose to order. He thought the Lord Mayor should in this matter take the Council into his confidence. They should hear the members of the deputation, and then allow them to go, and discuss the question at the Council. The Lord Mayor had only expressed his own personal view. The Lord Mayor said his observations were perfectly in order. He had expressed no opinion that he did not think would be shared in by every member of the Council. He hoped and believed that the city would support them, and he could only repeat that they did not oppose this extension of electric traction—quite the contrary—but the Corporation were to be the judges of what the proper system was. Mr. Clancy said they were not in favour of overhead wires. Mr. Little said it was an unusual thing for the views of the Council to be put before a deputation by the Lord Mayor. The Lord Mayor said he simply desired to convey what was the opinion he believed of the house. Mr. Nagle said he had to express the hearty thanks of the deputation for the kindness with which they had been received. As he stated at the close of his opening observations, they had the fullest confidence in the Corporation. Mr. Lawrence also conveyed the thanks of the deputation, the members of which then retired. The Lord Mayor subsequently moved the adoption of a report of a committee of the whole house having reference to the Dublin United Tramways Bill, 1895. It only recommended the reappointment of the committee, the reason being that in the course of the enquiries that had already taken place before the committee it had appeared desirable that the relations between the tramway company and the Corporation and the construction of the various Tramway Acts should be further investigated. Opinions on the subject had already been taken from Mr. Carton, Q.C., and Mr. Fitzgerald in London. Mr. Kennedy seconded the motion, which was agreed to.

Weybridge.—The Urban District Council have held a meeting at which the Highways and Lighting Committee reported that at one of their meetings, Mr. Bilney read a report on behalf of the committee appointed to inspect the Weybridge Electric Lighting Company's works, and it was proposed by Mr. Till and seconded by Mr. Brown, that, in the opinion of that committee, it would not be to the interest of the ratepayers either to buy the works of the Electric Light Supply Company or to invest the public money in any scheme for lighting the district. An amendment was proposed by Mr. Ward and seconded by Mr. Bilney, that it was desirable that the public lighting of that parish should be in the hands of that Council. The amendment was put, and negatived by five votes to three. The original motion was therefore carried. It was further proposed by Mr. Ward and seconded by Mr. Rowland, that the Council purchase standards and lamps for lighting with oil temporarily. This was carried *nem. con.*, and it was resolved that the surveyor report as to the number of standards required. At a further meeting of the committee, Mr. Bilney informed the members that at his request Mr. Spagnoletti, electrical engineer, was in attendance. It was proposed by Mr. Till, and seconded by Mr. Jarvis, that as the subject of buying the electric lighting works by the ratepayers had been decided in the negative it should not be again discussed by the committee. An amendment was proposed by Mr. Ward, and seconded by Dr. Powell, that the matter be re-opened and Mr. Spagnoletti heard. The amendment was carried, and Mr. Spagnoletti made a statement respecting the appliances that would be required, and the probable cost of maintenance. It was then proposed by Mr. Ward that in order to free the Council from taking the responsibility of charging the ratepayers with the cost of purchasing the present electric lighting works a meeting of the inhabitants be called by the chairman of that Council and the views of the inhabitants taken upon it. This was seconded and carried *nem. con.* It was proposed by Dr. Powell, seconded by Mr. Ward, and resolved that Mr. Spagnoletti be asked to prepare the scheme and specification and give an estimate of the cost of the proposed works. It was resolved that if the proposed works be not carried out, or if Mr. Spagnoletti be not appointed the engineer for carrying out the same, a fee of 25 guineas should be paid him. The chairman was about to put the recommendations of the committee to the meeting, when Mr. Brown proposed that the report of the expert be read. Dr. Powell seconded and the motion was carried. Mr. Spagnoletti's report was then read by Mr. Bilney. It first stated that with reference to the additional plant required to double the output from the Weybridge electric light central station, he thought it highly desirable to put down any additional plant as similar as possible to that now erected. With regard to the financial outlook of the undertaking, he considered that it was thoroughly satisfactory, as electric lighting companies generally were in a flourishing condition, and he thought that in the course of a year or two the public lighting would be able to be paid for out of the profits accruing from the private lighting. The electric light was in many places in the hands of corporations and district councils with excellent results. The street lighting of Weybridge would under the latest scheme require 154 lamps, and hitherto the sum of £2. 17s. 6d. per annum had been paid for each, making a total of £442. 13s. per annum. The lamp revenue from the present consumers was £400, and taking the public lighting at £2. 17s 6d. per lamp, which the Council would have to pay, showed an amount of £842. 13s, at which figure he thought the station would pay expenses, and, as the private consumers increased, the profits accruing from their consumption could go towards paying for the street lighting and thus reduce the rate. They might say the purchase of the station would cost £3,000, and the various new requirements would work out to £6,664. 5s. Then the estimate for the new street lighting circuit was as follows; 35 posts at a cost of £5. 12s. 6d., £196. 17s. 6d., and labour, etc., £300, giving a total of £496. 17s. 6d. To this must be added an amount for cable, which would depend upon the tender accepted; but they might say the whole cost of taking over the present works and laying down new machinery, etc., would amount to something over £8,000. The Chairman asked whether the Council would approve of the minutes of the committee, and the majority voted in favour of their approval. A public meeting has also been held to consider the lighting question, and this was followed by a special meeting of the Urban District Council, which went into committee to deal with the matter.

Proposed Derbyshire Electric Light Railway.—A meeting of gentlemen interested in a scheme for an electric light railway from Derby to Ashbourne, was held at the St. James Hotel, Derby, on Friday last, to consider the desirability of adopting suggestions contained in a report on the subject prepared by Mr. John Shaw, jun. The Chairman (Mr. C. E. Newton) said that although he did not live on the route it was proposed the railway should take, he took a very deep interest in the scheme. He thought there was a very real need for such a scheme, and that it was extremely desirable that communication between Derby and Ashbourne should be greatly improved, seeing how far round the existing railway went, and what a long time it took to cover the distance. Whether an electric railway was the best—and he really thought Mr Shaw had hit upon the right idea—or not was another matter. He had seen several electric tramways at work on the Continent and had very frequently travelled by them. He would not dare to give an opinion on the feasibility of the proposal of Mr. Shaw, but he considered some such scheme exceedingly desirable. Mr. Shaw then read the report he had prepared, of which the following is a digest: "To build and work an electric (light) railway on the overhead electric system as the method of traction, as compared with other various methods that are at present at work—viz., cable, electric accumulators, steam, and horse—has been proved to be the cheapest and most suitable. The cost of running per car mile by the overhead system, including all expenses, with the exception of guards' wages and maintenance of permanent way, is 4·06d., as against 8 57d. by steam. It is proposed that the line should be connected with the existing Derby tramway, which terminates on the Ashbourne-road. Thence it would run through Mackworth, Kirk Langley, and Brailsford, into the town of Ashbourne, terminating near the bridge. On only one portion of the line is there a really stiff grade, and that is for a mile at the Ashbourne end; but there is not any difficulty in getting over this. It is suggested that the line should be laid on the western side of the road, through nearly the whole length, as there is ample room. Through the villages it would probably have to run down the centre. There

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are telegraph poles placed at the side of the road, but there would not be any difficulty in obtaining power to remove these at a small cost. It has already been stated that it is proposed to use the overhead electric system. There are several of these, but the side wire system, as already in use in South Staffordshire, is without doubt the best, and it is recommended that it should be used in this case. The permanent way could be laid out at a cost of about £2,000 per mile. Paving would only be laid where absolutely required by the authorities. In all probability it would only be insisted upon through the villages and a small portion at each end of the line—viz., in Derby and Ashbourne. Electric signalling would be adopted to enable the crossings to be placed at as great a distance as possible from one another. Turnouts and fixed stopping places will be made where necessary, but a car could stop anywhere to take up or set down. The railway company average about 1¾ hours to run from Derby to Ashbourne (if punctual, which they very seldom are), and if the cars on the proposed electric railway are run at a maximum speed of 15 miles an hour and a mean speed of 10 miles an hour the journey could be completed in an hour and 15 minutes, thus showing a saving upon time between the light railway and the ordinary railway. The rolling-stock necessary for a line of this kind would consist of motor cars, trailers, and goods cars. A motor car would have to be equipped with motors of 20 e.h.p. each. These cars would cost approximately about £600 each. Trailing cars, which would only be used in summer, would cost about £200 each. The goods cars specially fitted up, would cost about £100. All the cars would be lighted by electricity. It is proposed to build the generating station near the Brailsford Brook, about 7½ miles from Derby, as that seems to be the best site, the heaviest part of the road being at the Ashbourne end. If sufficient hydraulic power could be obtained from the brook a large saving might be made in generating the current. The following is a rough estimate showing the cost of the line: Cost of permanent way, including materials, laying, etc., £25,600; overhead equipment, £18,600; generating station, including land, buildings, engines, etc., £12,000; rolling-stock, including six motor cars, six travelling cars, and six goods cars, £6,100; total, £62,300. The maintenance of the line would be very small, and the assistance it would be possible to give to the County and District Councils in delivering road materials would approximately pay for the maintenance." Mr. Shaw said that he had received a further estimate from Mr. Dickinson. It was to the effect that there would be 19 230 journeys made per annum, and that the mileage would be 250,000 per annum. The cost would be about 6d. per mile, or a total of £6 250 per annum. The population of the district was about 105,000, and assuming—as was quite reasonable—that the number conveyed annually reached that figure, the income from passenger traffic only would come to £18,800, which would leave a balance on the right side of £5 550. With regard to traffic along the road, 600 traps had been counted through the Mackworth Toll Gate on one Friday. After some discussion Mr. Holland moved that a committee be appointed to consider the question and report to a future meeting, the committee to consist of the following: Messrs. C. E. Newton, G. Meynell, T. O Farmer. J. Smith, Gilbert Murray, Edwards, R. Finney, Tomlinson, J. Pakeman, and W. R. Holland. Mr. Pakeman seconded, and the resolution having been agreed to, a vote of thanks to the chairman concluded the proceedings.

PROVISIONAL PATENTS, 1895.

AUGUST 6.

14801. **Improvements in the electrolytic production of oxides and salts which are insoluble, or practically insoluble, in the electrolyte.** Carl Lucknow, 70, Market-street, Manchester. (Complete specification.).

14804. **A combined electric bell press, pear press, and holder.** Osmond Yeadon Rhodes, 16, Grange-terrace, Chapeltown-road, Leeds.

14840. **Spray electrolysis.** Frederick William Durham, jun., Glenham Lodge, Station-road, New Barnet, London.

14842. **Improvements in electric condensers for use in polyphase and multiphase alternating-current circuits.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles S. Bradley, United States.) (Complete specification.)

14847. **Improvements in electrically-insulated pipes, and in the method of joining the same together, and in insulating cement or enamel used in connection therewith.** Alfred James Perton Whitaker and Frederick Gwilym Treharne, 45, Southampton-buildings, Chancery-lane, London.

14858. **Improvements in electric meters.** Jesse Harris, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

AUGUST 7.

14902. **Improvements in plates for secondary batteries.** Giuseppe Fabbro, 1, Queen Victoria-street, London.

14914. **Improvements in overhead conductors for electric railways and tramways.** William John Brewer, 15, Victoria-street, Westminster.

14937. **Improvements in electric block-signals for railroads.** Angus Cameron Gordon, 52, Chancery-lane, London. (Complete specification.)

AUGUST 8.

14973. **Improvements in prepayment apparatus for attachment to gas, electricity, or other fluid meters.** Wesley Webber, 4, South-street, Finsbury, London. (Date applied for under Patents, etc., Act, 1883, Section 103, April 16, 1895, being date of application in United States.)

AUGUST 9.

15024. **Electrolytic production of amalgams, and their utilisation.** Emile Andreoli and Gabriel Andreoli, 18, Somerleyton-road, London. (Complete specification.)

15057. **Improved means and apparatus for regulating or compensating for the variation of voltage in electric circuits.** Siemens Bros. and Co., Limited, and Henry Simpson Sayer Harvey, 28, Southampton-buildings, Chancery-lane, London.

AUGUST 10.

15069. **Improvements in and relating to telephony.** John Stuart Biggar, 70, Market-street, Manchester.

15114. **Improvements in electric current meters.** Carl Erben and Emanuel Bergmann, 18, Buckingham-street, Strand, London. (Complete specification.)

1 119. **Improvements in electrolysing apparatus.** Louis Achille Georges Emmanuel Roger Comboul, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1891.

18938*. **Incandescent lamps.** Langhans. (Amended specification.)

1894.

16473. **Telephones.** Ritter.

16943. **Ladder platform for telephone linesmen, etc.** Langlois.

17077. **Lenses and electric lamps.** Dando and Gwynne.

17542. **Electric storage batteries.** Liardet.

17808. **Arc lamps.** Lyon.

18999. **Electric fuses.** Thompson. (Société M. Gaupillat and Co.)

1895.

1512. **Arc lamps.** Ross.

7656. **Telephone apparatus.** Boult. (Rabbidge.)

8385. **Wire gauze brush for dynamos, etc.** Soar and Collier.

11752. **Electro-deposition of gold and silver.** Andreoli.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5⅝
Brush Company, Ordinary	2	2-2½
—— Nom. Cum., 6 per cent. Pref.	2	2-2½
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5½-5⅝ xd
Chatham and Rochester	—	—
Chelsea Electricity Company	—	6⅞-7½
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	131-134
City and South London Railway, Consolidated Ordinary	100	41-43 xd
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14-15 xd
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1-2
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A 1-200 of £50	100	—
Electric Construction, Limited	2	¾-1
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	2-2½
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	1-1½
Fowler-Waring Cables	5	¾-1
W. T. Henley's Telegraph Works, Ordinary	10	10½-11½
—— 7 per cent. Preference	10	15-15½
—— 4½ per cent. Debentures	100	104-107
House-to-House Company, Ordinary	5	3¾-4
—— 7 per cent. Preference	5	7½-7¾
India Rubber and Gutta Percha Works	10	19-21
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7½-8½
—— Pref.	—	—
Liverpool Overhead Railway	10	10½-10⅝ xd
—— 5 per cent. Pref.	10	15½-15⅝ xd
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	½-¾
Metropolitan Electric Supply	10	11-11½
—— 4½ per cent. First Mortgage Debenture Stock	100	116-119
National Telephone, Ordinary	5	5½-6½ xd
—— 6 per cent. Cum. First Pref.	10	16-18 xd
—— 6 per cent. Cum. Second Pref.	10	15-16 xd
—— 5 per cent. Non. Cum. Third Pref	5	6-6½ xd
—— 3½ per cent. Deb. Stock	100	105-107
Notting Hill Company	10	8½-9
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	5	7½-7¾
—— £4½ shares	4½	6-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8-8½
—— 7 per cent. Pref.	5	9-10
Swan United Ordinary	3	2-2½ xd
—— 4½ per cent. Debentures	100	104-107
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4½-4¾
Westminster Electric Supply, Ordinary	5	8½-8¾
Yorkshire House-to-House	5	5½-6½

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NOTES.

Mining Institute of Scotland.—A meeting of this institute has been held in Edinburgh at which Mr. Mitchell, the president, read a paper on "Electric Coal-cutting at Glencleland Colliery."

Industrial Exhibition.—A National Trades and Industrial Exhibition is to be held in the East End Exhibition Buildings, Glasgow, opening in November next, for about three months.

Telegraphy in India.—It has been decided to construct a direct telegraph line between Madras and Bezwada, and the work is to begin as soon as possible. The first section on the railway line between Royapuram and Ennori should be ready for traffic in September next.

Electric Traction in Egypt. — The American Consul-General at Cairo reports that street railways with electric traction are promised for Cairo next year, the concessionees being Belgians, and Alexandria is expected soon to follow suit. There are several bidders for an electric tramway from Cairo to the Pyramids, a distance of 10 miles.

The Falls of Foyers.—In the House of Commons on Friday last Mr. A. J. Balfour, asked by Dr. Farquharson whether he would take steps to prevent the destruction of the Falls of Foyers by an aluminium company, said he could add nothing to the statement made by the late Secretary for Scotland in May that to deal with the matter was beyond the power of the Government.

The Patent Office.—By reason of instances of mutilation of books within the institution, a warning from the Comptroller-General has been displayed about the rooms, to the effect that any person convicted of the offence is liable to six months' imprisonment. Also a notification is appended containing a threat of the withdrawal of the present facilities for reference should such malpractices continue.

New Telegraph Steamer.—Mr. A. R. Brown, the consul for Japan at Glasgow, has just placed with Messrs. Lobnitz and Co., of Renfrew, an order for a large twin-screw ocean-going telegraph steamer, completely equipped for laying, picking up, and repairing telegraph cables. It is to be hoped that this is the first of the orders which it is understood the Japanese Government contemplate placing in this country.

Electrolysis of Ores.—The electrolytic separation of metals from their ores is accomplished by first reducing the crude ore chemically to salts capable of being electrolysed. Different salts of the same metal, treated by different methods, yield to electrolysis with different degrees of facility, and produce the metal in varying degrees of purity and in variable quantity with the same current. On the nature of the preliminary process, therefore, depends the success or failure of the results. Among the various ores reduced in this manner are those of zinc, lead, copper, silver, gold, aluminium, sodium, and magnesium.

The Pacific Cable Scheme.—A proposal has been submitted to the Hawaiian Senate by Mr. Spalding for the laying of an American cable between California and Honolulu. The proposal requests the payment by the Hawaiian Government of an annual subsidy for 20 years of 50,000dol., exclusive of the cable franchise. It is doubtful what decision the Hawaiian Government will adopt in the matter. A Reuter's telegram from Honolulu, dated August 14, says: "The Bill for the construction of a cable between California and Honolulu was passed to-day. The annual subsidy was fixed at 40,000dol. for 20 years. The construction of the cable now depends on the obtaining of a subsidy from the United States Government."

New (?) Incandescent Lamp.—The German Patent Office, usually so alert, must have been caught napping when it recently granted a patent to Herr J. Wende, of Driesen, for an incandescent lamp which is described as follows: "The lamp consists of a round glass globe with two orifices on opposite sides, through which the electrodes are carried. The straight carbon filament is cemented to the electrodes. The side openings are fitted with metallic sheaths, and small screws secure the connection to the leads." Herr Wende also makes lamps on this principle with cross (+) filaments. But Bernstein introduced lamps of this kind many years ago, and the carbon filament was probably better arranged than in the Wende lamp.

Accidents in Mines.—Mr. Austin Kirkup, in his prize essay on "The Prevention of Accidents in Mines," observes that there is no doubt that the legislative enactments in connection with mines have had a most beneficial effect on the safe working of collieries. He thinks that too much attention has been given to providing a lamp which will be safe in explosive currents, which are seldom, if ever, met with in mines, and too little attention has been given to the improvement of the luminous power of the lamp, which is a very important matter. We certainly need more light in mines, but with the present system of oil safety lamps any improvement appears to be impossible. If the electric light could be combined in a portable form with a gas detector, the acme of success in the lighting of mines will have been attained. It is for those who are interested in the safe working of collieries to solve this problem.

Light Railways.—On Wednesday, in the House of Commons, on the vote for £42,495 in connection with tramways and light railways in Ireland, Mr. Strachey moved a reduction of £17,717, the proposed increase during the financial year. He pointed out that this policy of State-aided railways was not applied to England and Scotland. If it was a good system for Ireland, it was also good for other parts of the United Kingdom, and he objected to any further increase of the grants till all parts of the kingdom were allowed to participate in the benefit of these lines. After some further discussion, Mr. Balfour said this question, like other questions for the benefit of agriculture, would be considered by the Government, and, if there was public money available, they would consider how it could best be applied to the object suggested by the hon. member. After some further discussion the amendment was negatived without a division, and the vote was agreed to.

Electric Meter Competition.—The Royal Scottish Society of Arts, of 117, Great George-street, Edinburgh, offers for competition a Keith prize, of £50, for improvements in electric energy meters for domestic supply. Competitors must send a description, with working drawings, and a meter adjusted for a mean pressure of 115 volts and for a maximum of 4,000 watts. Preference will be given to meters suitable for alternate as well as continuous currents. Special importance will be attached to the minimum load at which the meter can register correctly, and to the energy absorbed by the meter when the consumer is using a light load or is taking no energy at all. The error should not exceed 2 per cent. at any load; error due to changes of temperature between 0deg. C. and 30deg. C. should be specified. The competitors must send in their papers, etc., not later than May 1, 1896. Their claims must be limited to recent improvements.

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A Pin for the Shahzada.—By special invitation of the Shahzada, Mr. W. H. Abdullah Quilliam, Sheikh-ul-Islam of the British Isles, and Moulvie Mahomed Baraket-Ullah, journeyed to London to take final leave of his Highness Prince Nasrullah Khan, who is about to depart from England. They were the bearers of two valuable articles to be presented to the Shahzada. They consist of a valuable keyless gold centre seconds chronograph hunting Liverpool-made lever watch, and of a pin to be worn in a turban, or Afghan hat, and is constructed entirely of the rare metal glucinum, better known as the metal of the emerald, and is only obtained from that particular species of precious stone by a lengthy chemical process, being finally freed by or released by means of electricity. This interesting article of scientific jewellery has been designed and constructed entirely by Prof. H. Nazrullah Warren, lecturer on chemistry, electricity, and metallurgy at the Liverpool Muslim College, in his private laboratory, 18, Albion-street, Everton.

Electricity in Turkey.—It seems that the Sultan has so far torn himself from the prejudices of his people against having anything to do with that heathenish discovery of the giaours, electricity, as to permit his Ministry of Marine to conduct at Ismidt a series of experiments with electrical projectors, which have apparently resolved themselves into a competition between the respective productions of Messrs. Schuckert and Co., MM. Sautter, Harlé, and Co., and M. Breguet, of Paris. Which projector was victorious we know not—the Turk is noted for his "unspeakableness." But the question of the introduction of electric lighting into the country of the Osmanli is on an altogether different footing, for while the Sultan's advisers are understood, under a heavy pressure of bakhshish, to be willing to place the matter before the Caliph in a favourable light, so to speak, the fact that some of the members of the Royal family are extensive shareholders in the local gasworks is considered to be a sufficient guarantee that electricity as an illuminant will make no headway in Turkey for some time to come.

A Gas Man on the Electric Light.—Mr. George Livesey, in addressing the shareholders in the South Metropolitan Gas Company, stated that he had "never before said a word from that chair about the electric light. That form of illumination had gained no footing whatever in their district. They had not shown any antagonism towards it. Indeed, on the contrary, they had given the electric light people every facility for laying the mains; but in the result, instead of being thankful, they were turning a bit spiteful, and this feeling was dragged in in connection with the company's profit-sharing business. In one of the journals devoted to the electric light interest the following observations occurred: 'We wonder if gas companies do this? Their consumers' meters always seem to run very fast, as though trying to outrun the works' meter. . . . They have such means of squeezing another 10 or 50 per cent. out of the public by increased charges, or saving at the works by reduced cleansing of the gas, or by a reduction of lighting power, that the great bane of profit sharing—viz., a year with a loss—never occurs?' That amused him, because it was well known when people got spiteful it was a proof that they were losing!"

Type-Setting by Electricity.—Many people were of opinion that the "Linotype" had done all that it was reasonable to expect, for some years to come, in the way of a type-setting machine, the *Financial Post* says. But this appears not to be the case; for wonderful stories are told of a new type-setting machine in Berlin called the "Electrotype." Its operations are described as automatic, the copy being fed into it in the form of a specially prepared slip of paper. A small electrotype motor drives each machine, which is said to turn out 20,000 ems per hour—about 10 times as much as an ordinary compositor will set. One boy can attend to several of these machines at once. It is said, "not only does the strip operate the keys of the machine, but the spacing is done automatically." This is a little strong. We can imagine mechanical contrivances doing a great many things, but how spacing between the words can be done automatically is more than our limited capacity for such operations enables us to imagine. At present we confess that we simply disbelieve the assertion altogether, and if an insupportable assertion like this is made about one part of the machine, it justifies us in taking a liberal discount off those laudatory comments upon it which have now set out on that long journey generally described as "going the rounds of the Press."

The Telephotograph.—The telephotograph is the name of a new Swedish invention, which claims to do for the eye something like what the telephone does for the ear. It is based upon the peculiarity of selenium, that its resistance to the transmission of electricity to a great extent depends upon the strength of the light to which it is exposed. The construction of the telephotograph is simple enough. A fine point of selenium is made to move in a plane by a mechanical arrangement in such a manner that it, moving within a limited compass of this plane repeatedly forwards and backwards, describes a spiral consisting of very close windings. An electric current passes through the selenium point, and the power of this current will vary according to the light to which the point at any given moment is exposed. The receiver is constructed in a similar manner to the above, except that a very susceptible incandescent light has been substituted for the selenium point. The intensity of this light varies in harmony with the light to which the selenium point is exposed. When the incandescent light is made to move in a similar manner to the movements of the selenium point, it will produce lights and shadows on the plane similar to those through which the selenium point passes in its plane. The despatching apparatus is enclosed in a case, something like a photographic camera, fitted with an objective, which can be so adjusted that the picture of the subject to be telphotographed is formed in the movement plane of the selenium point. The lights and shadows produced by the incandescent light of the receiving apparatus will then produce a picture identical with the one at the despatching station. This picture can be made visible in various manners, either through photography or by being directly looked at through some magnifier, or in a similar manner to the one used in a magic lantern. The rapidity of the movements of the selenium point through any one point of the picture must not allow of a greater interval than about one-eighth of a second, so that the corresponding impressions upon the eye of the beholder form a continuous complete picture.

Queen Anne is Dead.—The *Daily News*, which each day gives a couple of columns or so of matter much of which has an antediluvian odour about it, discovered on Friday last that "*A* French electrician, M. d'Arsonval, has succeeded in accurately measuring the electric energy of the torpedo fish." Some people are unaware that the *Daily News* is a daily comic paper. But it is. This item is published under the ironical heading of "This Morning's News.' Good morning, and never mind the soap. Moreover, the paragraph, to give it additional importance, is attributed to "Our Paris Correspondent." Possibly, the belatedness of the news may be due to the callousness of a lady journalist to anything but new dresses, but, in any case, the *Daily*

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News, if their sub-editors looked about in the proper channels, would have found all the details of M. d'Arsonval's experiments in the *Electrical Engineer* of August 9, page 145, which, though not headed "This Morning's News," antedates the Bouverie-street paper by a week. Equally up to date is the *Echo* of Saturday last, which lays forth upon the subject of the North Sea-Baltic Canal lighting. It then found out that the canal "will be amply lighted by electricity." We gave the full account of the method by which it had been lighted in our issue of June 21. Then we are told that the lighting is to be effected by one 16-c.p. lamp on each side about 300ft. apart. The fact is that, by the official information which we received, the lamps are of 25 c.p. and that the distances between the lamps average between 600ft. and 700ft. But possibly the *Echo* can only be depended upon when recording the "charitable" exploits of Mr. Passmore Edwards. The current issue of *Pearson's Weekly* states that "in Germany electric cars have been prohibited on the road which passes the Imperial Technical Institute. Experiments have shown that the current for the track affected the delicate instruments in the building, making scientific observations and experiments impossible." The proper particulars of the incident referred to were given in a note in this journal on August 2. Then *Fun* says that "one of the ideas for *next year's exhibition* at Amsterdam is an electrical restaurant. People are to feed electrically on electrically-cooked viands. After that, they will probably want to be electrocuted." The Amsterdam exhibition referred to is this year's, which was opened months ago.

Self-Propelled Road Carriages.—In connection with the offer of the *Engineer* of 1,000 guineas in competition prizes for self-propelled road carriages, the editors believe that the construction of such carriages may very well constitute a new branch of manufacture at least as important as that of cycles, which in a very few years has attained to enormous proportions. But they state that it is obvious that unless the use of vehicles propelled by steam, oil, gas, or electricity is sanctioned by the Legislature, no progress can be made in this direction. It will be remembered that an alteration in the existing Highways (Locomotives) Act was prepared and met with favour in the late Parliament, and would probably have become law but for the dissolution. It is most desirable that the existence of a demand for such a change should be brought to the notice of the new Government, and to that end they have prepared the subjoined memorial. They point out that energetic action at the present moment will be of far more value than at a subsequent period when Parliament becomes engrossed with matters which, however important for the nation in general, have scant interest by comparison for engineers. The memorial runs as follows: "Towards the close of the last Parliament the late Government introduced a Bill for the repeal of existing statutes, so far as they operate to prevent the use of light vehicles propelled by steam, or other motive power not employed in traction. The Bill was read a first time, but by reason of the dissolution did not proceed further. Your memorialists believe that the time has now come when such a measure should be passed into law. They point to France for an example of the use that is made of motive power upon roads, and they respectfully urge that this country should not be in a less favourable position. The fact that there is no opening for the use of light road carriages in this country by reason of restrictive statutes operates to prevent the development of a trade in such articles in competition with other countries where such restrictions do not exist. The passing of such a measure as that introduced during the last session of Parliament would lead to a large development of trade, and to the benefit of a large section of the operative classes of the country."

Personal.—Mr. Alfred Dickinson, recently manager of the South Staffordshire Tramways Company, has been the recipient of a handsome tribute to his worth. A large number of employés of the company assembled at the Darlaston depôt to make him a presentation. Mr. Dickinson is still engineer to the Electric Construction Company for the electric line, and is at present chief engineer to the Birmingham Central Tramways Company. Having accepted the Birmingham appointment, he has resigned his office at Darlaston. The presentation was made in the open air by Mr. W. H. Duignan (Walsall), who said that the company had assembled to show their personal respect and affection for Mr. Dickinson during the period he had held the office of manager of the South Staffordshire Tramways Company. Mr. Dickinson had discharged his duties for the past 12 years in such a manner as to earn the respect and affection of all who came in contact with him. They hoped he would have success in his new appointment, and would have greater happiness and comfort than in the past. He then handed to Mr. Dickinson an illuminated address, expressing regret at his severance from the company after 12 years of faithful and valuable service, recording high appreciation of his ability and general courtesy, and asking his acceptance of a drawing-room cabinet, desk, chair, and gold pencil-case as tokens of regret and esteem. Mr. Dickinson, in reply on behalf of his wife and himself, thanked those present for their expressions of goodwill. He said that in 1885—the year he took charge as general manager—the South Staffordshire Company's cars ran 442,634 miles, carried 3,438,819 passengers, while the earnings were £17,650. Last year the number of miles covered was 624,747, passengers carried 4,839,402, and earnings £30,984. So that in his management—and he gave it simply as a record—when he took charge, the earnings of the company were £17,650 per annum, and when he left it they were £30,984 per annum. He hoped there was a brighter future before the company. He was sure there was if an improved method of traction could be introduced.—Mr. E. C. C. Baly, University College, London, has been awarded honourable mention by the committee appointed by the Smithsonian Institution to award the Hodgkins Fund prizes for his paper, "The Decomposition of the Two Constituents of the Atmosphere by means of the Passage of the Electric Spark."

A Disclaimer.—Mr. Sporting Notions, of the *Referee*, on Sunday last wrote as follows: "If only the *Referee* were an illustrated paper! I mean, of course, 'illustrated' in the artistic acceptance. We are all modestly conscious that each contributor not only illustrates, but illuminates it—but that by the way. With liberty to insert a cut culled from the *Electrical Engineer* (whose editor I beg to thank for kind attentions), we could show how battles pugilistic are to be fought and won in the near future. At least how they will be fought and won if pugs adopt a patent for which one Donovan is to be held responsible. Let Mr. Donovan—Mr. Joseph Donovan, of Chicago—explain the fixings for himself, also for the world's benefit. I deeply regret inability to reproduce the cut depicting a gladiator armed in this apparatus and nothing much else. He has an electric stud on his nose and similar automatic registering devices on or about the jaw bones. The 'darby,' as fixed up with patent knobs, is marked out in sections, numbered or lettered, as targets are at rifle meetings. The authorities do not do this, you know, but enterprising newspaper agencies do, so that you can practically send by wire a plan of a target showing the hits. Says Mr. D.: 'It is well known that sparring or

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boxing is one of the most health-giving exercises in the whole range of athletics, developing endurance, stability of physique, a quickness of eyesight and action, and tending to bring out in its finest and quickest form every muscle of the body. Unfortunately, however, with all these good qualities there is a roughness and brutality with it, which has thrown it almost entirely outside the pale of legitimate athletics, and to eliminate these rough and objectionable features entirely to those practising boxing by padding over all the vulnerable points above the belt and providing each and all of these points with a registering device, so that all blows shall be rung up and registered automatically, thus reducing boxing to a simple test of quickness and endurance, and nothing more, is the principal object of my invention.' Bully for you, Donovan, my brave, inventive genius! We want chaps with brains like you to go a bit further and save a whole pile of trouble. Carry this great invention only to another step or two and we can reduce boxing to a sort of kriegspiel, with or without the mittens. Only to think of being able to sit at home and get all details of a big fight served up hot and put on the tape as one might a chess problem." In order to avoid errors, we may mention that we have paid no attentions, kind or otherwise, to Mr. Sporting Notions, and that we have never heard from Mr. Joseph Donovan, of Chicago.

The Patent Office and its Publications.—Mr. W. Fairburn Hart writes: "In the 'Twelfth Report of the Comptroller-General of Patents, Designs, and Trade Marks' for the year 1894, recently published by order of Parliament, special attention is directed to the fact that the largest increase in patent applications from foreign countries is from Belgium, Germany, and Sweden, 'the number from France (the report states) having remained, curiously, stationary during the past 10 years,' whilst 'the applications from the United States of America, which reached the number of 2,597 in 1890, have fallen off since that date, and amounted to 2,017 in 1894.' In view of the expected revival of trade, it is interesting to turn to one of the appendices of the same report and find how liberal our officials have been in donations of complete sets of the Patent Office publications to foreign Governments. Each set, it was officially announced in 1885, consisted of 4,040 volumes, and cost for printing and paper £4,270, complete sets having been presented to foreign countries as follows: Germany, eight sets; Belgium, two sets; and Sweden, one set; besides which abridgments of the specifications are sent to two additional places in the German Empire, and the 'Illustrated Official Journal of Patents' to another two places in Germany, and one in Belgium. The United States of America has received 12 complete sets of publications, besides 14 sets of abridgments of specifications and four copies of the 'Illustrated Official Journal of Patents,' for which since 1893 at the least 10 sets of United States specifications have been received in return, and these, the report states, may be consulted in the free public library of the Patent Office, London, and at the public libraries in Birmingham, Bristol, Cardiff, Dundee, Glasgow, Hull, Leeds, Manchester, and Sheffield. The Government of the United States of America is apparently the only country which sends more than one set of their publications in exchange for those received from this country, except France and Belgium, which formerly sent, if not at present, an additional set of publications relating to their specifications to the British Museum. If it is so important to obtain something like a fair exchange of patent publications from a country in which the applications received here are shown to be decreasing since 1890, why should not more than one set be obtained from Germany, and which set is only to be seen at the Patent Office Library in London? With the constant references that are made to keen German competition in all branches of trade, and in view of the fact that a British patent may be found to be invalid if a foreign specification has been deposited, so as to be available to the public, in a library in the United Kingdom, has not the time arrived when efforts should be made for obtaining an equivalent return of publications from the German Patent Office particularly, as well as from other countries, and when obtained to have them distributed to the public libraries, as is done with those received from America?"

The Counter E.M.F. in the Electric Arc.—Mr. W. H. Freedman, in the course of a long article on this subject in *Electric Power*, comes to the following conclusions: (1) There is a counter E.M.F. present in an electric arc depending simply upon the material of the electrodes and the temperature of volatilisation of that material, and this counter E.M.F. has a constant definite value for that material. For as far as the vaporisation of the material of the electrode is concerned this represents a certain amount of energy, and must be supplied by the electrical energy of the circuit. Therefore at this point in the circuit there must be a sudden fall in potential, such that this fall of potential multiplied by the current represents the energy necessary to vaporise the electrode. Such a counter E.M.F. must remain constant as long as the temperature of volatilisation of the electrode remains constant. (2) On account of the different temperatures, there must be a thermo-electric effect. That is, there is a thermo-electric couple of the material of the electrode and of its vapour, whose junction is at a much higher temperature than the rest of the circuit. The counter E.M.F. due to this phenomenon must depend upon the difference of temperature between the electrodes. Consequently it must increase with the length of the arc, as the temperature of the negative electrode rises. (3) It is fair to assume that two amperes of current will tear off twice as many molecules in the same length of time from the positive electrode as one ampere, in strict analogy to electro-deposition. If the matter of matter be doubled, the resistance is most likely halved, so that C R would remain a constant quantity. This would be so provided the temperature remained constant; but since the temperature rises with increase of current, and the resistance of flames decreases with increase of temperature, C R must actually decrease with increase of current. Now the decrease of voltage with the increase of current for a given fixed distance can be explained. By Ohm's law $C = \frac{E}{R}$. The effective E.M.F. in the present case is $E = V - x - y$; V = difference of potential between the electrodes; x = constant counter E.M.F.; y = variable counter E.M.F. Solving, we get $V = x + y + CR$. Taking any fixed distance, we see that V will increase as the current increases, since x remains constant, and both y and C R decrease in value. This, then, is the complete formula for the difference of potential between the electrodes, in which x = the constant counter E.M.F. depending upon the material of the electrodes and its temperature of volatilisation, y = the counter E.M.F. due to the thermo-electric effect being a function of the material of the electrodes and the difference of the temperatures; the higher temperature being that of volatilisation of the electrode, and the lower depending upon the material and size of the electrode, the current, and length of the arc. C = the current strength; R = the ohmic resistance of the arc depending upon the material of the electrodes, the length of the arc, and the temperature or the current. For any given material of electrodes

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analytically expressed in terms of length and current, $V = x + f(l_1 C) + C f^1(l_1 C)$; or in terms of temperature and currents, $V = x + f(t_2, t_1) + C f^1(t_2, t_1)$.

Refuse Disposal and Electric Lighting.—In continuation of this subject, a paper on which was read by Mr. Manville, M.I.E.E., at the recent Hull Congress of the British Institute of Public Health, and reproduced in our last issue, it will be interesting to note the following extract from the remarks made by Mr. S. J. Beaman, of Warrington, at the same congress. Mr. Beaman said: I venture to presume that most, if not all, present are of opinion that the most common-sense and rational manner of the disposal of such a conglomerated mass of offensive material as town's refuse is by burning it. But in this utilitarian age the mere process of burning it simply to get rid of it will not long be tolerated or countenanced, but it will be requisitioned to serve some public and beneficial purpose other than merely producing a clinker for concrete, or for the clinker being ground into mortar when mixed with lime. In this electric lighting age the steam generated by the burning of the refuse can be most advantageously utilised. Hitherto due justice has not been done to the destructor furnace as a steam generator; it has been looked upon as of secondary importance, simply as an auxiliary, and as only capable in some small degree of lessening the consumption of coal. This is scarcely a matter for surprise taking into consideration the very meagre results obtained. These actual results vary very considerably; some authorities give them as low as 3 i.h.p. per cell and some as high as 15 i.h.p. per cell, calculated upon the basis of 20lb. of steam per hour as equal to 1 i.h.p. If we take the higher estimate, 15 i.h.p. per cell, I think you will agree with me that even this is far from satisfactory when compared with others. I am not going to enter upon a dissertation of the calorific value of town's refuse, because it differs very much in its composition in different localities and even in the same locality at different seasons of the year. Mr. William Warner, of Nottingham, in his paper which he read two years ago, "On the Disposal of Refuse," after citing the amount of steam produced per cell at several towns, says: "It will be seen from these figures that we cannot look forward to a large amount of power for electric lighting, and it is even questionable whether the power generated could be usefully adopted for that purpose." The question that naturally suggests itself is, Can destructor furnaces burning town's refuse generate sufficient steam power (without at the same time impairing their hygienic properties as destructors) as to become the most important factor in the generation of electrical energy? I unhesitatingly answer it in the affirmative. Mr. G. Watson, of Leeds, whose paper and figures have been quoted times without number by sanitary engineers who have written upon this subject, calculates upon the analysis of the products of combustion of Mr. Horsfall's furnace, and upon the specific heats and weights of the component gases, that 1,192lb. of water can be converted into steam at 70lb. pressure by the combustion of ¼ ton of refuse in one cell in one hour. Supposing an engine to consume 20lb. of steam per indicated horse-power per hour, we have theoretically from one cell in this system 59·6 i.h.p. all the time it is working. But Mr. Watson significantly adds, "So much for the theory." This theoretical 59·6 i.h.p. per cell when reduced to the practical amounts to only 15 i.h.p. per cell, which is greatly in excess of the steam produced per cell by other systems.

Road Traction.—The eighth annual meeting of the Institute of British Carriage-Builders was opened at Tunbridge Wells on Tuesday, when Mr. John Philipson, of Newcastle, the president, delivered an address, in the course of which he said: "The fact that a Bill has recently been introduced in the House of Commons to amend the law with respect to the use of locomotives on highways, is one that no coachmaker can regard with indifference. Its object is to exempt carriages, propelled by other than horse power, from the regulations of the Locomotives Act in cases where they are not used for traction purposes. Now, the Locomotive Act was passed mainly with the object of applying to engines used for traction purposes, and it was totally inapplicable to the light horseless carriages which are used in Paris and other parts of France. By the law of this country, the road engine cannot proceed at a greater speed than four miles per hour in the country, and two miles per hour in the town, and the object of the new Bill is to remove the legal obstacle as to speed in order that we may try those light self-propelled carriages which are used in France, where they are very correctly called "automobiles." It is not to be believed that our country, which builds locomotives as excellent as any that are made, and which for a long time led the world in their production, can any longer refrain from following the lead of its neighbours in experiments which have yielded such valuable results. The opinion has recently been expressed in the *Standard* that if once the trammels are taken off this method of locomotion in the United Kingdom, the development that will follow will assuredly grow to extraordinary proportions, and I am bound to confess that I concur in this view. It may become a reality which we, as coachmakers, will have to face in the near future. I am not pessimist enough to believe that carriage manufacturers, as we now understand it, will suffer to any great extent, or that the production of harness will be less. The number of horses and carriages did not decrease as was predicted when the locomotive displaced the coach. It is possible to create a demand and a new industry without injuriously affecting those already in existence. We have seen this in the marvellous extension of cycling. But if horseless carriages come into general use in this country, it will be our duty, as assuredly it will be to our interest, to take care that their manufacture, in so far as concerns everything but the motor, is the work of the carriage manufacturer. In the interests of our trade we must watch the improvements which are being constantly effected in machinery, and particularly in the application of electricity. To a limited extent we have availed ourselves of its advantages in the lighting of carriages, and I hope that we may soon be enabled to adopt the electric welding process described by Mr. Manville last year. It is a powerful auxiliary within the reach, if not of the coachmaker, at any rate of those who supply him with some of his ironwork. I need not dwell upon the importance of what is termed the efficient union of the materials of which a structure is composed. In the case of such parts of a carriage ironwork as the axles, the tires, and the bodyplates, the necessity for efficient union is imperative. There is always a doubt about a weld, no matter how good it may appear and how well it may bear certain tests. An imperfect weld may be the result of several causes—too little or too much heat, insufficient hammering, the presence of vitrified oxide, or of dirt. It is most frequently the latter. In the case of electric welding, the condition of purity is fulfilled. We obtain an equal temperature in the pieces to be joined, as the inner parts of the metal may be brought up to be fused, and the operation is not only perfectly performed, but it is done much quicker than by the older methods. The method offers great advantages to the manufacturer of coach axles, and its use would be a guarantee to his customers of the reliability of his productions."

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THE POTENTIOMETER AND ITS USES.

BY ELLIS H. CRAPPER, A.I.E.E.

(Concluded from page 147.)

§ 5. *Measuring Higher E.M.F.'s.*—The previous example is a very convenient method for the determination or comparison of E.M.F.'s of single cells; but since a D.P. of only two volts is maintained between the ends of the potentiometer wire, it is evident that some modification is necessary to measure higher E.M.F.'s than two volts by comparison with one standard Clark cell. It will be apparent from a glance at the figure below that the same principle upon which the potentiometer itself depends, is applied in the additional piece of apparatus required, which is sometimes called a *volt-box* and sometimes a *multiplying resistance.* This is marked V B in Fig. 6, and, in fact, is nothing more than a divided resistance, arranged in sections so that the resistances of the different sections are definite fractions of the whole resistance between x and z. By this means it is clear that the D.P. between the ends of one of the smaller sections—as $x y$, say—is a definite fraction of the fall of potential along the resistance $x z$. The volt-box is usually arranged so as to allow any convenient fraction of the total fall of potential along $x z$—such as $\frac{1}{10}$, $\frac{1}{100}$, or $\frac{1}{1000}$—being used as may be desired. The first $\frac{1}{10}$, or, as we shall express it, 10 : 1 arrangement—*i.e.*, the ratio of the total resistance of $x z$ to the resistance of the smallest section—is suitable for the measurement of the E.M.F.'s of batteries, whilst the $\frac{1}{100}$ and $\frac{1}{1000}$ (or the 100 : 1 and 1,000 : 1) arrangements are suitable for higher E.M.F.'s; so that we are enabled to compare the E.M.F.'s of several hundred volts with the E.M.F. of a single-standard Clark cell.

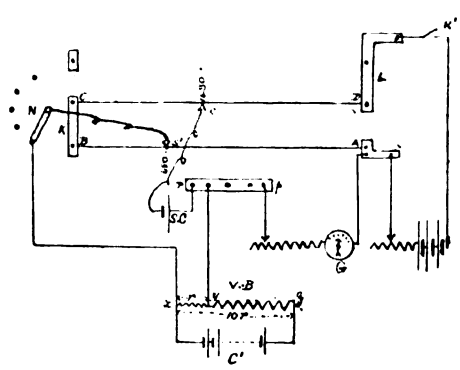

FIG. 6.

Fig. 6 shows a diagrammatic sketch of the complete arrangement suitable for the determination of the E.M.F. of a battery, and will of itself, from what has already been said, explain the theory of the method adopted. C^1 is the battery of E.M.F., E^1 volts which is required. $x z$ is the volt-box, set up with the 10 : 1 arrangement.

As before, the slider, s, is placed at the division corresponding to the E.M.F. of the standard cell, S C, for the temperature of the room, as given in the table previously, and a D.P. of two volts maintained between the terminals, A D, of the potentiometer wire. In the case shown the E.M.F. of the standard is 1·43, since the slider, s, is at the division 1,430, and the slider s^1 is placed at 680, which gives 0·68 volt as the D.P. between the points x and y. But the E.M.F. of the battery, C^1—*i.e.*, the D.P. between x and z—is 10 times the D.P. between x and y, consequently, the E.M.F., E^1, is $10 \times 0{\cdot}68$ or 6·8 volts. It will be noticed that with the arrangement as shown, any E.M.F. up to 20 volts may be measured; also by arranging the volt-box to give 100 : 1, up to 200 volts may be measured, and so on.

§ 6. *Standardisation of Voltmeters.*—To check the readings of a voltmeter, the same method is employed, but it is necessary to point out that arrangements must be made so as to permit of various voltages—so as to include the whole range of the readings of the voltmeter under test—being put between the terminals of the voltmeter, as required. This is done as follows: the voltmeter is connected across the terminals, $x z$, of the volt box, to which are also connected the terminals, $u v$, of an incandescent lamp, the voltage of which should be the same as the maximum reading of the voltmeter. The incandescent lamp forms part of a circuit supplied with electricity from a dynamo or other source giving a constant E.M.F., so that the E.M.F. at the terminals, $u v$, of the lamp may be made equal to the maximum voltage the voltmeter will indicate. The D.P. at the terminals of the lamp may be varied by moving the slider, s^4, along a variable resistance, $v w$, placed in series with the lamp and the source. As shown in Fig. 7, this variable resistance, or any part of it, may or may not be included in the lamp circuit as desired, by moving the slider, s^4.

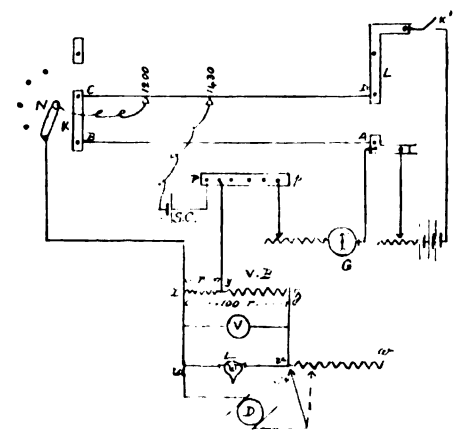

FIG. 7.

The supposed calibration of a voltmeter to read between 40 and 120 volts will illustrate the method of procedure. The volt-box is arranged to give 100 : 1, and a 120-volt lamp is inserted between u and v. The variable resistance, $v w$, in series with the lamp, is arranged so that the D.P. between the lamp terminals may decrease by five volts for each movement of the slider s^4. For instance, when the variable resistance, $v w$, is cut down, as shown, the D.P. at the lamp terminals will be 120 volts, the dynamo or other source giving a constant E.M.F. of 120 volts. When the circuits are properly balanced, the slider s^1 will be placed at division 1,200 on the potentiometer, since the D.P. between x and y is $\frac{1}{100}$ of the D.P. between the terminals, $x z$, which is the same as the D.P. at the terminals of the voltmeter. And 1,200 on the potentiometer gives 1·2 volts between x and y, consequently the voltmeter should read $1{\cdot}2 \times 100$ or 120 volts. It must be remembered that the accuracy of the measurements depend upon the exact adjustment of the potentiometer and the standard cell when setting the instrument up, and repeated readings should be taken with slider S_1 when only the standard cell is in circuit. When the first section of $v w$ is introduced, the reading will be 115 volts, and so on. From the potentiometer readings we, of course, get the various voltages at the terminals of

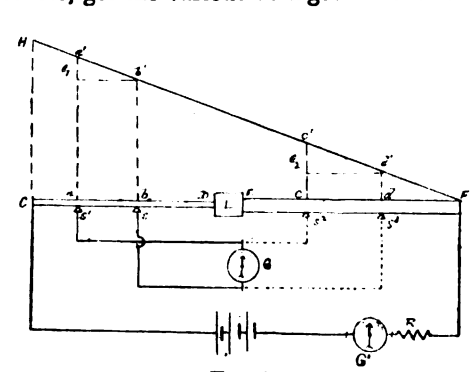

FIG. 8.

the lamp, and consequently the same voltages at the terminals of the voltmeter, and by noting the corresponding readings, a curve may be drawn indicating such errors as may exist. If a suitable incandescent lamp is not available, an equivalent resistance may be inserted between u and v.

§ 7. *Resistance and Conductivity of Wires.*—Advantage is also taken of the fact that the fall of potential between two points in a wire is proportional to the resistance between the two points, to compare resistances and to

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determine the conductivity of wires. As is probably well known, one of the most exact and satisfactory methods of measuring very small resistances is by means of the fall of potential along a wire. The theory of the method is very simple, and will be readily grasped from Fig. 8. In the figure, C D and E F are two wires stretched over scales between the terminals C D and E F, D and E being connected by the thick copper piece, L. If one of the wires, C D say, which we shall call the standard wire, be made of pure copper, and the lengths of the wires denote their resistances, we can at once determine the conductivity of the other, E F, in terms of that of pure copper. If a battery of constant E.M.F. be connected to C and F, then the ordinate, C H, denotes the D.P. between the terminals C and F, and there will be a gradual fall of potential from C to F; and since, as we have already seen, the slope of the potential, H F, is a straight line, it is an easy matter to get the value of the ratio of the D.P.'s between any two sets of points, as, for instance, between the points a and b and c and d. The potential at a is denoted by the length of the ordinate $a\,a^1$, and at b by $b\,b^1$—that is, the D.P. between a and b is $(a\,a^1 - b\,b^1)$, which we will denote by e_1; similarly e_2 denotes $(c\,c^1 - d\,d^1)$ the D.P. between c and d. In practice, to get measures of e_1 and e_2, we have simply to make contact with the wire at a and b simultaneously with the sliders, s^1 and s, when we shall get a deflection, D^1, with the galvanometer, G, which is proportional to e_1; similarly, sliders s^2 and s^3 give a deflection, D^2, proportional to e_2 by making contact at c and d simultaneously. Consequently we may write—

$$\frac{e_1}{e_2} = \frac{a\,b}{c\,d} = \frac{D^1}{D^2}.$$

If we let

d_1 = deflection per unit length of standard wire $= \dfrac{D^1}{\text{cms. in } a\,b}$;

d_2 = " " " wire to be tested $= \dfrac{D^2}{\text{cms. in } c\,d}$;

r_1 = resistance of standard wire, l_1 cms. long;

r_2 = " wire, l_2 cms. long;

c_1 = conductivity of standard wire;

c_2 = " wire;

s_1 = area of cross-section of standard wire;

s_2 = " " " wire.

Then, since $R = \dfrac{\sigma\,l}{s} = \dfrac{l}{c\,.\,s}$, the general formula for resistance, in which σ is specific resistance and c specific conductivity, we may write the following equations:

$r_1 = l_1 / c_1 s_1$, and $r_2 = l_2 / c_2 s_2$; but $e_1 = C\,r_1$, and $e_2 = C\,r_2$. Therefore, $e_1 = C\,r_1 = C\,l_1 / c_1\,s_1$, and $e_2 = C\,l_2 / c_2\,s_2$. From which we get

$$\frac{e_1}{e_2} = \frac{r_1}{r_2} = \frac{l_1\,c_2\,s_2}{l_2\,c_1\,s_1} = \frac{D^1}{D^2} \quad . \quad . \quad . \quad \text{(III.)}$$

Equation III. is simplified if l_1 and l_2 be taken as unit length, and becomes

$$\frac{e_1}{e_2} = \frac{c_2\,s_2}{c_1\,s_1} = \frac{d_1}{d_2} \quad . \quad . \quad . \quad . \quad \text{(IV.)}$$

therefore

$$c_2 = c_1 \times \frac{d_1}{d_2} \times \frac{s_1}{s_2}. \quad . \quad . \quad . \quad \text{(V.)}$$

If $s_1 = s_2$, then $c_2 = c_1 \times \dfrac{d_1}{d_2}$, c_1, the conductivity of the standard wire, is expressed as a number, that of pure copper being taken as the standard of reference and denoted by 100. The method of applying these principles is shown in Fig. 9, in which the letters correspond with those in Fig. 8.

In the potentiometer shown in Fig. 5, the standard wire, C D, is made of platinoid ·355mm. in diameter, consequently a preliminary test is necessary to determine its conductivity with reference to pure copper. This is done by connecting a pure copper wire between E and F, which, for the time being, is the standard wire, its conductivity being 100. From a large number of tests, the conductivity of the platinoid wire of this potentiometer has been found to be 4·75; this number is marked on the instrument for future use, and need not be determined each time the instrument is used. It will be noticed in Figs. 8 and 9 that two galvanometers are shown connected up, one, G, a high-resistance galvanometer, from which the readings are taken, whilst the other, G^1, is used simply to check the constancy of the current during the test. To determine d_1 and d_2, the slider s^1 is fixed at any convenient position, a in C D, and the slider s at b, so that the D.P. between a and b gives a convenient deflection, D^1. Dividing this by the number of centimetres between a and b we get d_1.

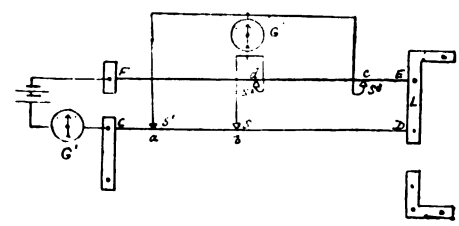

Fig. 9.

In a similar manner we get d_2 by means of sliders s^2 and s^3. Then

$$c_2 = c_1 \times \frac{d_1}{d_2} \times \frac{s_1}{s_2} = 4{\cdot}75 \times \frac{d_1}{d_2} \times \frac{s_1}{s_2}.$$

The particulars and results of an actual investigation respecting the conductivities of two samples of German silver and brass wires will now be given as examples. The diameter of the standard platinoid wire is ·355mm.

(I.) German silver wire, ·75mm. diameter, stretched between E and F.

D_1 was 328 when $a\,b = 10$cm. $\therefore\ d_1 = 328/19$;

D_2 was 95 when $c\,d = 39$cm. $\therefore\ d_2 = 95/39$;

since $s = \dfrac{\pi}{4}(\text{diam.})^2 \therefore s_1 = \dfrac{\pi}{4}(\cdot355)^2$, and $s_2 = \dfrac{\pi}{4}(\cdot75)^2$.

Substituting these values we get

$$C_2 = 4{\cdot}75 \times \frac{328}{19} \times \frac{39}{95} \times \frac{\pi}{4} \times \frac{\cdot355 \times \cdot355}{\cdot75 \times \cdot75} \times \frac{4}{\pi}$$

$$= 7{\cdot}54$$

II.—Brass wire, ·355mm. diameter

D_1 was 345 for 20cm. $\therefore\ d_1 = 345/20$

D_2 was 240 for 45cm. $\therefore\ d_2 = 240/45$

and $S_1 = S_2$,

$$\therefore\ C_2 = 4{\cdot}7 \times \frac{345}{20} \times \frac{45}{240}$$

$$= 15{\cdot}36.$$

As the connections for the determination of specific resistance and the measurement of very small resistances, shown in Fig. 10, explain themselves, it will be sufficient if we briefly describe the standard resistance, S R, and the switch, K^2. The standard resistance consists simply of ten

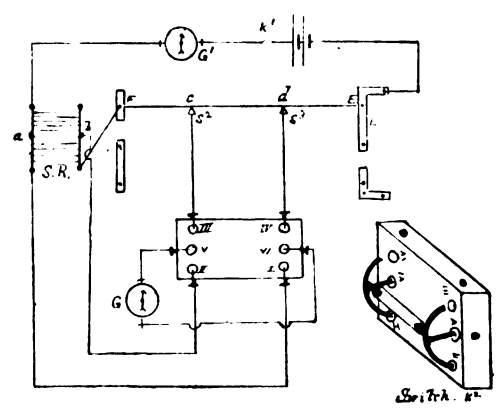

Fig. 10.

0·1 ohm resistance coils—accurately determined—connected in multiple arc, so that we have at hand a 0·01 ohm standard coil, which, within considerable limits, will not be heated by large currents passing through it. When we know the D.P. existing at its terminals, we can determine the resistance between any other two points by means of the D.P. between them, provided the same current passes through both. The switch is simply a Pohl's commutator modified, and consists of an ebonite base with six mercury

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cups, I., II., III., IV., V., and VI., each connected to a terminal. The high-resistance galvanometer is connected to cups V. and VI., in which are placed the two metal uprights of the switch, which is hinged so that contact may be made quite readily with either pair of cups, I. and II., or III. and IV. By means of this switch the galvanometer, G, is placed in circuit with the points a and b, or with c and d. When G is in circuit with a and b, the deflection D^1 measures e_1, the D.P. between a and b, and when III. and IV. are in circuit with G the deflection, D^2, measures e_2, the D.P. between c and d. From a consideration of the principles it is obvious that several methods may be adopted in making these tests. We may find D^2 for a definite length between c and d, and calculate the value of r_2, from $r_2 = r_1 \times D^2 / D^1$, r_1 being ·01 ohm, since,

$$r_2 / r_1 = e_2 / e_1 = D^2 / D^1;$$

or we may vary the distance between s^2 and s^3 until $D^2 = D^1$, or, in other words, find a length of the wire which has the same resistance as the standard. An actual example of a determination of the specific resistance of an aluminium wire ·089cm. in diameter, will now be given as a worked example.

D^1 was 120 when the standard coil was in circuit with G; D^2 was 200 when 35cm. of the aluminium was in circuit.

Then, since $r_2/r_1 = e_2/e_1 = D^2/D^1$, the resistance of 35cms. of aluminium was

$$r_2 = \cdot 01 \times \frac{200}{120} = \frac{1}{60} \text{ ohm.}$$

The specific resistance is calculated from the formula $R = \frac{\sigma l}{s}$, where σ = specific resistance, l = length in centimetres, and s = cross-sectional area in square centimetres; $s = 00621$ square centimetres.

$$\frac{1}{60} = \frac{\sigma \times 35}{\cdot 00621}, \text{ and } \sigma = \frac{\cdot 00621}{60 \times 35} = \cdot 00000296 \text{ ohm.}$$

$\therefore \sigma = 2{\cdot}96$ microhms.

§ 8. *Measurements of Currents and Calibration of Ammeters.* We shall in this test simply point out one or two details, as Fig. 11 explains itself. By means of slider s^1 the D.P.

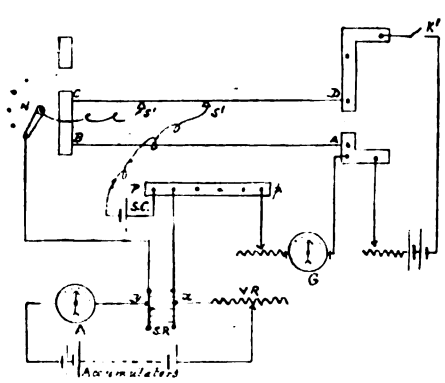

FIG. 11.

between x and y may be measured when a steady current—preferably from accumulators—is sent through x y, a known resistance, the magnitude of which is suitable for the current flowing. In all cases the resistance of x y is small, so that the D.P. between x and y does not exceed two volts. Then, since $\frac{\text{D.P.}}{\text{resistance}}$ = current, the current is easily determined. If an ammeter is to be checked, it is placed in series with x y, as at A, and the current is varied by means of the variable resistance, V R.

MUNICIPAL ELECTRICITY.*

BY JAMES PERRY.

For six years, as part owner and engineer, the writer has been connected with the public and private supply of electricity in Galway, and he has thought that his views and experience in this department might have some interest to his brother municipal engineers. The counties in Great Britain have been municipalised, those of Ireland are about to be, and there appears to be a prospect of legitimate shortening of our title. Most of us as officers are entitled "surveyors." It is a good old title, honoured and ennobled by the men who have preceded us, and not to be lightly discarded; but it records our origin, and marks the gradual growth in complexity of our functions. The rapid march of civilisation during the last 100 years, the steady rise of the standard of comfort and decency, the recognition of the mutual dependence of all citizens, rich and poor, in preventing disease—appliances for street cleansing; systems of sewerage, with pumping machinery; waterworks; gasworks; tramways—necessitates that the city surveyor shall be an engineer in the widest sense. As a specialist in a department he might attain greater riches and wider fame; his part is to select and control specialists as a commander-in-chief controls the complex and highly scientific departments of a modern army. Electricity—electrical engineering if some prefer so to speak—is forced upon us, and we have got to do our duty in regard to it as we have done our duty by the other human refinements which have preceded it. Most of us are specialists in some direction as a relief and variety from the routine of official duty, and some of us are no doubt electricians as some of us are artists or musicians; but an electrical engineer is not necessarily an electrician, just as a mariner is not necessarily an astronomer. There has been for some years in the public mind a confusion between electricians and electrical engineers which would be paralleled by supposing mariners and astronomers to be the same. Astronomers have done good work for mariners, and electricians are doing good work for engineers, but a mere electrician is not an engineer, and when he undertakes an engineering job, he necessarily makes a mess of it. There has been a good deal of messing. Let us take two examples: The scientific gentleman who is mainly responsible for the "London Supply" is a man of undoubted ability, and as an electrician his reputation has scarcely suffered by the gigantic failure of that venture. The financially most successful man is probably Edison, who is by training neither an engineer nor an electrician (he is reported to have sworn in court that he did not know Ohm's law), but who appears to be endowed in a high degree with a combination of the qualities of common sense and ingenuity which makes him comparable to our own George Stephenson.

The engineer has to deal with commonplace electricity: he should in general treat it as Peter Bell did the primrose—let his cow eat it and turn it into butter. The engineer's electricity is comparable to a leather belt or steel shafting and gearing. It is not a source of power; its humble function in the telephone, telegraph, electric motor, electric lamp, is to transmit power to a distance. Pretentious youngsters and high-falutin newspaper men may talk of the age of steam to be succeeded by the age of electricity; they might as well talk of the coming age of leather belts or of steel shafting. Why should a dairy maid, whose business it is to make good butter, bring to her butter-making the botany of the plants eaten by the cows, the physiology of the cows, and the chemical composition of the butter? It would be useful for the intelligent dairymaid to know how many ounces of butter she ought to get from a gallon of milk, the temperature at which butter comes, how much water to leave in the buttor, and how she can best wash out all the remains of the milk, and she should have proper appliances to enable her to carry out the processes cleanly and properly.

The generation of electricity is purely a question of mechanical engineering. The laying of mains involves digging and paving, the wiring of houses is a kind of plumbing, the laying of an electrical tramway is a piece of ordinary tramway engineering. The electricians have a great variety of units which they have variously named and symbolised, so that it becomes more and more difficult for plain men to understand what they write, and they tend more and more to become a select half-dozen—for the whole world—who can dispute with one another in a

* A paper read before the Incorporated Association of Municipal and County Engineers at Londonderry.

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language which no outsider understands. Engineers who desire to keep sane should avoid trying to comprehend the discussions in which English prepositions and conjunctions are mixed up with block letters and German text letters which in mercy to the eyes of Germans have been banished from their books) and occult phrases and names of dead persons, but it is necessary to know something of the way in which electricity is measured, and useful to know the small equation which expresses Ohm's law.

Electricity leaving a central station passing round an external circuit and returning to the station may be compared to an endless rope driven by a pulley in the station. If you conceive of a rope of this kind passing round capstans and through tight places of one kind and another, you will see that when it is made to circulate it will turn the capstans and heat the tight places. Note the rope comes in as fast as it goes out, and no faster, but it comes on to the pulley tight and leaves it slack. Let us call the speed of the rope amperes and the tightness of it volts; the speed is the same at every part (except for elastic movements which we may neglect), but the tightness varies. As many amperes return to the central station (assuming there is no transforming) as leave it, but the volts vary from point to point. Now, if we multiply the tightness or pull by the speed we have the power transmitted at any point. Volts multiplied by amperes measure power. It is of no great consequence how the units, ampere and volt, have been fixed. The volt means pressure or tightness of the rope; the ampere means speed or quantity per second; amperes and volts multiplied together are watts; and now we are in familiar ground, because 746 watts are a horse-power. When 1,000 watts run for an hour it is called a Board of Trade unit. A unit of electricity, for which we in Galway charge 3d., used in printing or bottle-washing, or 5d. used for lighting, is equal to $1\frac{1}{3}$ h.p. for one hour. This is all absolutely exact; the unit of electricity can be stated as being 2,554,155 foot-pounds. When, however, we have to compare the value of a unit of electricity for lighting purposes with that of 1,000ft. of gas, we have the elements of lamps and burners coming in in ways which allow of a considerable field for discussion between gas conservatives and electric radicals. It is fair at this time of day to accept Gordon's estimate made long ago, that one thousand of gas is equal to 10 units of electricity, which would make electricity at 3d. equal to gas at 2s. 6d.

"Amperes" in our analogy are units of speed.

"Volts" " " pull or pressure.

Volts × amperes are "watts."

746 watts are one horse-power.

1,000 watts for one hour make one unit of electricity

The engineer has also to deal with the unit of resistance called an "ohm."

If there were no resistance to the rope running there would be no difference in the tightness between where it comes on and where it leaves the driving pulley—that is, there would be no loss of volts; but there is resistance at every supporting pulley and at every capstan and every tight place, and at all these places the rope is less strained coming on than leaving: it is losing volts owing to resistance all along its course. This resistance might be called negative volts, but it is advisable to have a distinct unit for it, the "ohm."

In any continuous-current circuit the three quantities concerned expressed in these units are connected by a relation which is shown by a simple algebraic equation, and is known as Ohm's law:

$$\text{Amperes} = \frac{\text{volts}}{\text{ohms}}.$$

This relation comes into most of the electric calculations which the engineer has to make.

If we consider the resistance to the right of A and B, and that the loss of volts between A and B is due to that resistance, it will be seen that there is a further small loss from friction between the rope and the driver, and if we wish to speak of the total pull at the maximum point in the circuit, account must be taken of this friction; we speak of the difference of volts between two points on a circuit, but the E.M.F. of the circuit is different in the way illustrated above.

An endless rope driven as shown above illustrates machines or lamps worked in series in which the same current passes through them all, and there is a more or less great drop of voltage at each lamp or machine. A modification of the illustration shows lamps or machines worked in parallel. Conceive the different machines or lamps to be worked by separate bands or fine ropes which combine through the driver, up to points A and B, to act as a single rope, and at these points separate to the several machines or lamps; we must, however, modify our idea of amperes by considering not the velocity, which is supposed to be constant, but the sectional area of each separate band as representing amperes.*

Transforming.

The power of a current is measured by amperes × volts = watts; any arrangement by which for a very small loss these two factors are varied is called a transformer. Any machine by which we obtain a mechanical advantage, wheel and axle, lever, etc., is a transformer of mechanical power. With alternating currents electrical transformation is very simple; it is not so simple for continuous currents, and in this lies a great point in favour of alternating currents for certain circumstances. There are disadvantages, and we have electricians who show some partisanship both for continuous and for alternating currents. The engineer will use whichever bests suits his special conditions. A continuous-current transformer is a machine which revolves; the alternate-current transformer has no moving parts. Accumulators, which are lead plates in cells filled with sulphuric acid, besides acting as stores for energy, are also transformers. (A diagram drawn by the author showed the arrangement for a constant-current supply with accumulators. In this A represented the engine working a shunt dynamo, B the accumulators, and C the incandescent lamps.)

Continuous-current dynamos are of three kinds (neglecting peculiarities of armature, etc.):

(1) Shunt dynamos, in which the field magnets are excited by a shunt of fine wire connecting the poles of the machine.

(2) Series dynamos, in which the total current produced by the machine passes by a thick wire round the field magnets.

(3) Compound dynamos, which have both series and shunt windings on the same machine.

Shunt dynamos are used with accumulators, because whether they revolve as dynamos or as motors they revolve in the same direction; there is always more or less chance of the dynamo and engine being driven by the accumulators. Series dynamos are used for arc lamp lighting, and compound dynamos for incandescent lamp lighting without accumulators. For five years the writer has every night run arc lamps off a shunt dynamo, and he has charged accumulators with both compound and shunt dynamos. With a turbine at an inefficient speed he has also run incandescent lamps direct from a shunt dynamo without any injury, so that the above rules in some respects are flexible.

The part of a central station in which there is any complication is the accumulator portion. Accumulators if used for storing are in first cost very expensive as compared with gasholders, and if used as regulators they involve some little complexity in connections and switches. In London, accumulators should not give very much trouble where the companies who manufacture them agree to maintain them at a percentage of their first cost per annum; but in out-of-the-way places like the West of Ireland, they will give trouble till they are set free from the last restraints of the Patent Office. With proper arrangements on the premises for remaking defective plates, the maintenance of accumulators will give very little trouble. Accumulators are specially suitable for water power because they allow of the power being utilised during the whole 24 hours. There is a loss of energy in accumulators of about 25 per cent.

* If moment can be taken as amperes it will apply to both analogues.

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MAINS.—THE THREE-WIRE SYSTEM.

The filament of a incandescent lamp is of such a thickness (or sectional area) that a given uumber of amperes being forced through it heats it to the required brightness (the brightness determines the life of the lamp). In two lamps A and B, suppose A to have a filament twice the length and half the sectional area of B. A will only require half the amperes, but it will need twice the volts (or pressure) to give the same candle-power as B at the same brightness. If there was no practical limit to the fineness of filaments, we could save largely in the copper of the mains by keeping the voltage up to the limit fixed by the Board of Trade as low pressure; but it appears to be desirable to have lamps of 8 c.p., and the conditions of filament appear to limit the voltage to about 110; with cheaper electricity enabling us to use a minimum lamp of 16 candles, we could double the voltage and very much increase the capacity of our mains.

By Ohm's law, volts = amperes × ohms, but the rate of work = amperes × volts;

$$\therefore \text{rate of work} = \text{amperes}^2 \times \text{ohms (in watts)}.$$

Every current in a conductor does work by heating it; this is waste, and the rate of waste is proportional to the amperes^2, so that it is seen how important it is to keep the amperes low by keeping the volts high. It is of the greatest importance to keep the mains at an equal voltage, and our copper must be proportioned to the drop we calculate for in designing the mains. Now, suppose we calculate for a drop of two volts from one end to another of a series of lamps, and suppose the amperes to be 50 and the voltage of the lamps to be 110. If we replace the ordinary lamps by others having filaments twice as long, the cross-section remaining the same, the voltage must be increased to 220, but the lamps will give twice the light and there will be no more than the two volts drop, because the amperes will not have been increased; but if we had arranged to get twice the light at the 110 voltage with the same loss, we should have had to multiply the quantity of copper by 4, so that we save three-fourths of the copper by doubling the voltage. We need not have our double filaments in one bulb, but we may place two common lamps in series between the conductors, they need not be close together, they may be in different apartments, but they must be turned on or off together. We shall get rid of this inconvenience if we run a small main connecting the middle wires of the lamps, because if the lamps are unequal on the two sides of the middle the balance of current flows up or down the wire. This is the three-wire system. The three wires need not be carried into the houses, but consumers should be balanced on the mains in the streets.

It would appear that the network of a low-pressure system should be fed from centres about three-quarters of a mile apart. The network should consist of two conductors laid down each footpath, one of them being cross-connected to form the middle wire of a three-wire system. The size of the conductors of the network should be (probably) uniform, extra business in certain localities being provided for by extra feeders. The network should be fed by mains from which no services of any kind must be taken. These feeders will vary, so that whatever the length may be they will all have the same resistance, so that the drop in volts in each feeder shall be the same. The secondary centres may all be supplied from a principal centre, accumulator transformers being used in the secondary or feeding centres. There are continuous-current motor transformers, of which we do not hear much in actual practice, but it would appear to be quite feasible to send a high-pressure current from compound dynamos arranged to give a fixed voltage at the centres, and transform it down to the low-pressure centre voltage. Two years ago we met suggestions for small step-up transformers placed in mains so as to allow of the voltage to drop two volts below normal, and at such a point transform it up four volts, but we have heard little of this device in practice. In Galway we shall probably complete our half-mile radius of low-pressure area, and deal with the outlying straggling places with alternating currents.

The enemy to be met everywhere in a continuous-current system is electrolysis. If you maintain two pieces of copper wire at different voltages, and dip them in a solution of sulphate of copper, that which is of the higher voltage will waste away and the wire of lower voltage will become thicker. If two naked copper conductors rest on porcelain or glass insulators in an underground culvert, it is almost impossible to prevent damp from making a connection with the earth. Pure water is almost an absolute non-conductor, but the word almost condemns it, because the faintest trace of hydrated oxide of copper improves its conducting power; probably its first encouragement comes from common salt, which is a universal enemy. The rate at which the "earth" becomes good is a rapidly increasing one; it results in one main being eaten through at the insulator and the other main forming an incrustation of metallic sodium at its insulator, and this incrustation may drop off, and meeting with actual wet strike a light which fires gas which may have accumulated in the culvert from gas-mains. These culverts are exceedingly expensive things to construct; there is difficulty in keeping them drained and ventilated. Water accumulates in them; they are regular traps for water, owing to the steady temperature of the ground and the varying temperature of the air. Service connections are troublesome. Various makes of continuously insulated lead-covered mains are in the market; the difficulty with them is in service connections. Where such mains are armoured, the light character of the armouring does not promise long life in damp soils. The threading of cast-iron protecting pipes on a long length of main is difficult unless the pipes are roomy. The writer has had experience with different kinds of mains. The variety of practice in this respect indicates an uncertainty which experience will by-and-by settle; we shall in the end have only one or two kinds. The writer has devised a main of his own, but as it is yet untried he had better say little about it. Leaky electric mains, besides wasting themselves away, may do some injury to gas and water pipes buried in the ground close to them. Wherever the iron pipe is at a higher voltage than the earth in contact with it, there rusting of the iron is promoted. Tramways with rail returns may do much damage in this way. For electric lighting by gas-engines, accumulators are a necessity; any kind of throb or irregular turning shows very distinctly in incandescent lamps. For some time the writer ran incandescent lights off a compound dynamo driven by a wooden water-wheel; if the wheel stood idle for a short time so that the upper part got drier, and consequently lighter, than the lower portion of the rim, the rise and fall of the heavy part of the wheel could be seen in the lights till the wheel got equally soaked with wet all round. If alternators could be satisfactorily run with gas-engines, the question of storage of electricity would be solved, because gas may be cheaply stored, and a series of gas-engines might be put into work as the load increased and put out as the load diminished; the only inconvenience in such an arrangement being that it would be necessary to have a generating plant with reserves equal to the maximum demand. Another way of meeting the varying load is to keep the engines going all the time at a steady electrolytical manufacture of some kind which might be considered a by-product of electric lighting. With the method of differential charging to consumers the writer has but little sympathy; it is a throttling kind of action. Electric men have sooner or later to face the gas men in deadly combat as suppliers of light, and they have got to do it by reducing prices and standing on a common platform of equal rates. A differential charge for power supply is legitimate; it comes into the competition with the gas men. In the few remarks made by the writer in seconding a vote of thanks to the borough surveyor of Belfast, he suggested a 3d. rate per unit. Other people have come to this 3d. unit, and the writer is now inclined to halve it as a reasonable rate in large towns. When electricity is to be had at 1½d. a unit, a 16-c.p. lamp will keep lighting for 13 hours for 1d.

With alternating currents the writer has hitherto had no practical experience, but he is contemplating using them in the near future. The beautifully steady power of turbines, with which we work in Galway, appears to suit alternator work, but the obvious applicability of accumulators as a mean of making the most of a water power decided our commencing with continuous current. When increase of

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business drives us to auxiliary power, we shall no doubt run alternators at night with our turbines and charge accumulators with them in the daytime.

A new form of tramway is just now being experimented with, worked with alternating currents, and it may possibly set at rest for ever the vexed questions between overhead trollies and underground trollies, no form of trolly, good or bad, being needed for the new kind of tramway.

The public and private lighting should be all done from the same mains. In Belfast the area selected for an experiment is an early-closing shop, and it is in this respect not the best. It would be improved by adding public to private lighting. The best kind of work is public lighting, which continues during all the hours of darkness; the worst kind is that of early-closing shops, which in summer take no light at all, and in winter they all light up together for a short time. The Belfast experiment appears to be further handicapped with dear fuel; town gas burned in gas-engines and costing 2s. 3d. a thousand is a lavishly expensive fuel. Belfast is a plucky, egotistical place, and the mass of people will not long be grovelling in worship of a row of smoky chimneys in Cromac-street.

The subject is probably too large to be satisfactorily treated in a paper of this kind. The purpose of the paper, however, is not to be a treatise on the engineering applications of electricity, but to reassure municipal engineers who are kept hard at work in an already complicated routine that this new claimant of attention is no way dangerous; that he is amenable to familiar and kindly treatment. The writer, while engaged in a varied practice, has formed a strong attachment to this new professional friend, and he is desirous that he shall receive kind treatment from his brother surveyors when he knocks—as he soon shall do—loudly at their doors.

THE NEW SCIENCE OF ELECTRIC HEATING.*

BY W. S. HADAWAY, JUN.

Heat is so closely allied to an adequate shelter in warming, and to food in cooking, that we must regard it from the practical standpoint of a prime necessity, and in treating of its generation and distribution base our deductions largely on whether the owner of a particular form of heating apparatus can operate it economically, and whether the user, or party to whom the heat energy is furnished, can employ it as cheaply as other forms of heat supply, with reasonable regard for collateral advantages. A heating system, to be an advance on existing methods, must be a source of wealth to the owner and a source of economy to the user.

A system of heat and electrical generation and transmission derives its value largely from the benefits of concentrated control, like other systems of public works. We are to regard heat agents as commodities which can be economically generated, transmitted, and applied. Electricity as a heat agent is not to be regarded as a source of heat, as that expression is generally understood, but, technically, as the high-potential heat factor in a tele thermal system, where the heat secured is generated by simple resistance; or, we may employ electricity as an agent for producing available heat in operating a thermal engine by means of motors.

Of the fuel consumed under good steam-boilers at least 65 per cent. of the heat energy is available for useful work Steam in the best of steam-engines theoretically possible can only transform 25 per cent. of the boiler energy into active mechanical work, and in practice 12½ per cent. is not generally exceeded. The engine work can be very economically transformed into electrical energy, in which form, considering it as heat, transmission losses are relatively small. In good steam and electrical practice the heat engineer can secure about 10 per cent. of the fuel energy in electricity, and of the balance of the fuel energy may write off 35 per cent. as direct loss and 55 per cent as indirect loss. The indirect loss can be utilised with a properly arranged system of steam distribution over limited distances, and the combination of the electrical energy, available for heating purposes at varying temperatures, but usually above 212deg. F., and the exhaust steam, available for heating purposes at temperatures below 212deg. F., the writer has termed a multi-potential thermal system, in which electricity is employed as the high-potential heat factor and exhaust steam as the low-potential heat-factor, and in which the heat energy is available for use in a telethermal system. That is, in practice we have a system in which the ratio of high-potential heat to low-potential heat is about 1 to 5, figured from thermal units and not temperatures, and in which the total fuel efficiency is about 50 per cent.

In domestic and industrial work we find two broad classes of heat control. The first class includes operations requiring diffused heat on a large scale, as in room and water heating, or heat of low potential and large quantity. The second class includes processes where heat is used at high temperatures and in small volume, as in cooking and laundry work and in many industrial operations, or heat of high potential and small quantity. A reasonable estimate of the relative thermal units employed in each class is found, after careful investigation, to be about 5 to 1, assuming as a line of temperature demarcation 212deg. F. The average temperature differences between the two classes are not in the same ratio as the quantities with this unit, but are sufficiently great to warrant a distinction between prices for heat energy at low potentials and at high potentials. What this difference in price should be can only be conjectured, but a fair rate of charge would seem to be not far from four or five times as much for high-potential heat as low-potential heat.

A practical illustration of the multi-potential heat system may be found in the requirements of a modern apartment house in which there are several families, each with a kitchen and small laundry under the tenants' control, and with electric lights, steam heat, and hot-water supply from a common source. The house equipment would consist of boilers, engines, dynamos, etc. The incandescent lamps, ovens, grills, flat-irons, etc., would be heated by electricity. The rooms and the water for bathing and culinary purposes would be heated mostly by exhaust steam. The owner would derive practically two profits from the fuel burned—a direct revenue from heat supplied for cooking and laundry work, and an indirect revenue from utilising the secondary products of the first.

In present practice the owner equips the house with gas ranges, which are a source of direct revenue, not to himself, but to the gas company. Electric lights, hot water, and steam heat are furnished by the owner, and figured as part of the rental value. The lights load is of so brief duration that the hot water and steam heat must come from live steam for a considerable part of the day. With a somewhat larger engine and dynamo, on the plan outlined, the live steam used would be largely supplanted by exhaust steam on account of the larger load-factor, besides providing a direct revenue to the owner to pay for fuel, labour, etc. The cost to the user of the electrical energy for cooking and laundry work at four cents. per horse-power hour is not greater than gas at 1dol. per 1,000, provided all water-heating is omitted and the electrical apparatus fairly well controlled. The user or tenant secures a great number of collateral advantages, which represent the same advantages for less money or more advantages for the same money, and the owner may convert an expense into a revenue.

The illustration brings "electric heating" within our definition of an advance in heating systems, and shows a sufficient reason why the subject should receive the respectful attention of capitalists, property owners, and their architects. It also shows that the expression "electric heating" is an unfortunate one, as the problem is one for the heat engineer, in which steam and electrical engineering are elements, and in which the electricity used is the thermal equivalent of only about one-sixth the heat energy distributed and applied.

There is, to the writer's knowledge, no installation extant completely illustrating the multi-potential system of heating. The Yaryan installation of central-station hot-water heating at Toledo, O., described in *Heating and Ventilation* (February

* From the *Engineering Magazine* (New York).

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15, 1895), closely approaches it, and lacks only the application of electricity for cooking and laundering in the houses heated, and this installation is especially noteworthy in using water for thermal storage and circulation in connection with the exhaust steam heat storage. In the New York *Electrical Engineer* (April 5, 1893) will be found a description of the Springfield (III.) electric light and steam distribution plant. This installation approaches the hypothetical illustration closely enough to remove all reasonable doubt as to the strict accuracy of the deductions made for the multi-potential system.

In developing electric central stations the desirability of a large load-factor is apparent. With full knowledge of the requirements in various cases, data on electric cooking and heating have been patiently and carefully collaborated. The result entirely confirms theoretical deductions as to the extent to which the station can provide at a profit the energy for cooking and heating. There is no doubt that the central station can furnish at a profit the high-potential factor in the thermal system. The question now rests as to whether the customer or householder will find a divided heat supply desirable. Of the six parts used, the electric central station can provide one-sixth, the high-temperature part, the customer himself burning coal or gas to furnish five-sixths of the heat. The electric central station can operate electrically-heated chafing dishes and pots for five o'clock teas (replacing the alcohol lamp); curling-irons; plate warmer in the pantry; laundry irons; small water-heater for nursery; bath and dressing-room warmer, etc.; and these specialties can all be made to increase revenue without adding materially to the construction account. At a five-cent rate per horse-power hour, the devices enumerated are perfectly practicable, and other specialities, like shaving-mugs, toddy-heaters, egg-boilers, hot-plates, etc., are coming into use. These are all of value as a source of revenue to the electric central station and of convenience to the users, but it must be doubted whether, with so small a percentage of residence lighting as is now connected, and with the inability to offer but a partial heat supply when connected, electric heating apparatus, in which the heat is derived from simple resistance, will entirely provide the balance in the load sought for.

To illustrate the capacity of an electric station as a heat producer, we may compare the prices charged by the New York Steam Company and the Edison Electric Illuminating Company of New York, both operating in the same district and supplying steam and electricity respectively. Using the figures given by Dr. C. E. Emery as the basis of charges for the Steam Company, we find that it furnishes heat to large consumers at 40 cents per 1,000 kals, the kal being the equivalent of 1,110 thermal units. For 40 cents, 1,110,000 heat units are supplied. Taking the Edison Company's rates, and using the 50 per cent. discount as the rate to a large user, 40 cents will purchase eight horse-power hours, or 20,518 thermal units. The ratio between the two is nearly 54 to 1; or, as a loss must be figured in the case of steam dependent upon the temperature at which the condensed water is allowed to escape, practically 50 to 1. It would be unjust to leave the figures on the mere heat equivalent of the two forms of energy, as high-potential heat energy is almost universally secured by localising a small proportion of fuel energy and allowing the rest to escape, and is consequently worth more per heat unit; but, even were we to admit as a reasonable charge five times as much for high-potential heat as for low-potential heat, the ratio is still 10 to 1, and indicates what might be accomplished could the two plants be run conjointly for a multi-potential heat supply.

Lord Kelvin, in an article on "The Economy of the Heating or Cooling of Buildings by Means of Currents of Air," published in the Glasgow *Philosophical Proceedings*, vol. iii., December, 1852, and followed by mathematical demonstrations in the *Cambridge and Dublin Mathematical Journal* for November, 1853, has made some most interesting deductions:

"In the mathematical investigation it is shown that, according to the general principles of the dynamic theory of heat, any substance may be heated 30deg. above the atmospheric temperature by means of a properly-contrived machine driven by an agent spending not more than about one thirty-fifth of the energy of the heat thus communicated, and that a corresponding machine, or the same machine worked backwards, may be employed to produce cooling effects, requiring about the same expenditure of energy in working it to cool the same substance through a similar range of temperature. When a body is heated by such means, about $\frac{34}{35}$ of the heat is drawn from surrounding objects and $\frac{1}{35}$ is created by the action of the agent, and when a body is cooled by the corresponding process, the whole heat abstracted from it, together with a quantity created by the agent, equal to about $\frac{1}{35}$ of this amount, is given out to the surrounding objects."

In editing his "Mathematical and Physical Papers," Lord Kelvin added the following interesting note under date of June 26, 1881: "The method of cooling air in unlimited quantities described in this article has been realised by Mr. Coleman, first, in refrigerators used for the distillation of paraffin, and, after that, in the Bell-Coleman refrigerator for carrying supplies of fresh meat from North America to Europe; in a great refrigerator recently sent out for the abattoir at Brisbane, Queensland, etc."

When Niagara is set to work for the benefit of North America through electric conductors, it will no doubt be largely employed for the warming of houses over a considerable part of Canada and the United States. But it is probable that it will also have applications, though less large, in other cold countries to multiply the heat of coal and other fuels, and to utilise wind and water powers (with the aid of accumulators) for warming houses.

The accomplishment of this form of heat control would enable us to construct uni-potential thermal systems, in which the high-potential factor would be secured directly by the heat of resistance and the low-potential factor by employing electricity as agent to operate by a motor a device like that outlined by Lord Kelvin. A system of this sort would appear to largely increase the central-station load-factor, and we would simultaneously introduce a large summer load by employing the same device, in reverse cycle, for cooling.

Of course many minor modifications of the two thermal systems outlined will suggest themselves. The gist of the whole matter is that for electric heating (or its synonym, central-station heating) to be economical a multi-potential thermal system must be operated, which is entirely feasible over moderate distances; or, assuming that electric central stations are to continue to run with the present deplorable fuel economy, the second or uni-potential system is the only feasible one, considering the whole subject in its broadest sense, and remembering that, while the device to accomplish the results sought is shown to be theoretically possible, it has not yet been entirely developed.

Where a complete thermal system is to be constructed, with coal or low-cost carbonaceous materials as fuel, the multi-potential combination is the direct way to secure high fuel economy and profit to the owner and user; and where only the mechanical equivalent of heat is available, as from motors, water powers, gas-engines, etc., we must interpolate a device for diffused heat control to heat buildings and water for use in same, in addition to the energy for high-temperature work, which we can profitably secure from direct heat of electrical resistance.

Results already accomplished in electric heating depend wholly upon the high-potential factors of the broad systems outlined. The time is not ripe for a comprehensive review of the collateral benefits derived from a highly localised form of heat energy, our concepts of the elasticity of which are only measurable by concepts of the rigidity of the ether. Instead of a concerted effort to create a field of use for the apparatus by constructing complete thermal systems, nearly all of the applications have been made as minor incidents in systems of electric lighting and power already established. This, of course, is logical pioneer work, but it fails to reach the vital elements necessary for full development.

The famous "Electrical-Heater Man" at the Franklin Institute in 1884 was the butt of the practical jokers among his co-exhibitors. The apparatus there shown was the first form of the electric car-heater with which to-day upwards of 5,000 cars are equipped. The status of the

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electric car-heater is peculiar; it cannot be regarded as an economical device, but rather as a public requirement. An electric car is too small and crowded to admit of an economical and efficient isolated system of heating. Again, very little actual heat is required under average conditions, but rather a small amount of sensible warmth, uniformly distributed to each passenger on the basis of individual effectiveness. This can be met by an electrically-heated radiant at an energy consumption of less than 100 watts per square foot of surface, and in the common 20ft. car 20 square feet of radiating surface are sufficient for average conditions, and 35 square feet of radiating surface for extreme conditions.

Too little regard has been paid to the item of individual effectiveness in rendering cars comfortable. So much energy has been wastefully used in air-warming, even under average conditions, as to render the power consumption a most serious matter. The result is to give an unjust impression as to the cost of making cars habitable by electric heaters, and in the case of elevated roads using large cars in trains the item is a still more important one, as the energy for heating may equal or exceed that for propulsion. Again, in the case of elevated roads there seem no good reasons why the small rooms in the stations along the line should not be heated by the same agency as the cars, and in economical work of this magnitude we appear to be forced back to the uni-potential system using electricity as agent.

In small cars the heat of resistance is not excessively expensive. As in the case of the Vaudeville Theatre installation in London, there are peculiar local conditions which, as practice has proven, can be satisfactorily met with resistance heaters. But, while under ordinary circumstances we can heat bath and dressing rooms in residences by resistance heaters quite cheaply, considering intermittent use, we would not attempt to heat the whole house by the same means. If electric roads would locate their stations contiguous to business blocks and utilise their exhaust steam for heating purposes, there would be no difficulty in meeting the requirements of car and station heating on a large scale by resistance heaters. The *Railroad Gazette*, March 22, has given some interesting figures on the cost of heating cars by electricity, in which comparisons are made between heating large cars by electricity and by steam. As a general rule, the smaller the divisions of space and the more intermittent the use, the greater is the economy of electric heating, and we may include in this rule water heating as well as space heating.

Cooking by electricity is an important part of electric heating. In practice it means the accomplishment of high-temperature processes by resistance heaters, using other sources of heat energy for the hot-water supply and, preferably, water-boiling processes, as in vegetable cooking. One of the most complete analyses of this subject which has appeared was published in *Science* (September 15, 1893). The deduction is made that electricity at about 11 cents per horse-power hour is as economical as the common coal-range for cooking provided the electricity is used to heat an oven, the hot water being secured from outside sources. This appears to presuppose a radical change in cooking methods and apparatus, and, while this is undoubtedly proper in order to get best results, practice has seemed to require at the outset a more elastic system, in which the utensils conform to the generally accepted notions of what shapes and sizes should be.

To this end an experimental plant has been operated for 15 months in charge of a cook without special instructions as to the best method of operating the apparatus for economy, the desideratum being that good cooking shall be done and the utensil disconnected from the circuit when the cooking is completed. The equipment consisted of an oven, broiler, portable stoves, spider, plate-warmer, coffee-pot, and small tea-kettle. The result has shown that with apparatus conforming generally to the accepted notions of cooking utensils, the cost of electric cooking is practically equal to that of the gas and coal stove as generally run when electricity is supplied at four cents per horse-power hours. This does not show what can be accomplished under best control, but is a practical result in common usage.

The economy of electricity as a thermal agent in cooking is not doubtful, provided the uses to which the various forms of heat supply are put are proportioned in accordance with their heat equivalents, limiting electricity to high-temperature work. In combination with steam, both live and exhaust, there appears to be no reason why hotels and public institutions, operating their own plants so as to secure a multi-potential system, should not employ electricity in cooking very extensively, solely for the purpose of economy; for electricity in a well-designed isolated plant costs much less than four cents per horse-power hour, especially if we utilise the by-products of its generation in useful work, as would be the case in a complete thermal system. Ethical considerations in connection with electric cooking are of value after the economy and simplicity of the apparatus are established. Cleanliness, localisation of heat at predetermined temperatures, and coolness of the kitchen are important factors in connection with the servant problem. The use of electric cooking apparatus in cooking-schools is important, as constant temperatures are easily produced over extended periods.

In industrial work the applications of electric heating are rapidly multiplying. Nearly every manufactory of size has its own electric plant, and can secure electricity at low cost. In operating sad-irons and tailors' gooses, small glue-pots, soldering-irons, pitch-heaters, etc., sufficient compensating advantages are found to offset increased prime costs, in case they occur, and the outlook for extended applications in the industrial field is favourable. The ability to minutely sub-divide the heat energy, or, in other words, the elasticity of the system, makes it of special importance for use in manufacturing work.

It is impossible, within the prescribed limits of this article, to give more than a passing glance at the different factors in electric heating. We may perhaps best sum up the various sides of the problem as follows:

1. In constructing a thermal system we may employ electricity as the high-potential heat factor, by resistance heaters, or we may employ it as agent in operating motors to drive a suitable machine to secure diffused heat control.

2. In a multi-potential thermal system the useful heat available is pratically five parts low-potential heat and one part high-potential heat. In domestic life the ratio of heat required is found to be practically five parts diffused heat and one part high-temperature heat. Over limited distances we may therefore economically operate multi-potential thermal systems using electricity as the high-potential factor.

3. Electric heating is synonymous with central-station heating, presupposes the same generic elements, and requires for economy a complete thermal system, in which due regard is paid to proportioning the work done in accordance with the heat equivalents of the factors employed, all of which must be in such form as to constitute elements of a tele-thermal system.

4. Where the mechanical equivalent of heat only is available, as from motors, water powers, gas-engines, etc., we can economically employ electricity only for high-temperature work; for diffused heating on a large scale we must employ it as agent.

5. By constructing complete thermal systems, in which steam and electrical engineering are factors, the heat engineer can make electric heating a source of wealth to the owner of the system and a source of economy to the user of the heat energy, and therefore secure an advance on existing heating systems.

A Big Switchboard.—A big switchboard is about to be installed in the Government printing office, Washington, D.C. It will be made of Tennessee marble, set in an iron frame, will present a surface of nearly 1,700 square feet, and it will be fitted with special instruments, all the omnibus bar connections and clip-holders being of solid copper. Several tons of copper will be used in the connections. The switches will range in capacity from 800 to 1,000 amperes, and the board will be used for the distribution of current throughout the building for power purposes. Crocker-Wheeler electric motors will be laid down for the operation of all the printing presses and other machinery in the building. The Solar Electric Company, of New York, is supplying the switchboard.

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MUNICIPAL ELECTRICITY.

This is the title of a paper read before the Municipal Engineers' meeting at Londonderry, but the paper might have better been given some other title. It is really of twofold character; in the first place pointing out that electrical engineers may very comfortably put aside much of the hair-splitting science of the electricians without detriment to the work undertaken, and, in the second place, the elementary knowledge that an engineer must know, is discussed. We had hoped upon first hearing the title of the paper to have had an exhaustive discussion from an official source of the reasons for and against municipal action in electric light matters. However, there are one or two points in this paper which may give rise to interesting discussion. The poor electrician is at first rather sat upon, but, like the astronomer, he has his uses, and it would be a sad day for electric progress if the pure electrician were to abate one jot of his energy. The astronomer provides the nautical almanack for the sailor, without which the latter would be unable to traverse the trackless ocean with the calm confidence he now does. The electrician, it is true, does not provide an almanack, nor does he usually move in advance so far as new departures are concerned, but he carefully analyses every new departure, points out the laws followed, indicates any variation from such laws, and generally puts weapons in the hands of the practical man which enables him to improve again and again the details of the new departure. The great difficulty is to decide upon the authority speaking. We cannot follow the *Pall Mall Gazette* in looking upon Herz as an authority, nor can we follow the *Scientific American* in its sweeping assertion that "No insulator of magnetism is known." We have long laboured under the impression that Lord Kelvin—then Sir W. Thomson—introduced iron-clad galvanometers for the purpose of insulating the needles from outside magnetism. We are sorry to learn that Faraday's, Webb's, and Thomson's experiments in this direction are erroneous. However, when we want to save a valuable watch from straying lines of force, we shall not hesitate to put it upon a bed of wool in an iron box and trust that it will in the end be found magnetically unharmed. However, the *Scientific American*, in its issue of August 10, gives us a good many more facts—query, fictions—of this nature.

Among electricians there are a good many debatable points, but upon many questions all are agreed. It is unfortunate that those who have not closely followed the various controversies cannot in general determine questions of agreement and non-agreement.

The most important question, however, for our readers, is in the suggested price per Board of Trade unit. The paragraph in question reads as follows:

"In the few remarks made by the writer in seconding a vote of thanks to the borough surveyor of Belfast, he suggested a threepenny rate per unit. Other people have come to this threepenny unit, and the writer is now inclined to halve it as a

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reasonable rate in large towns. When electricity is to be had at three-halfpence a unit, a 16-c.p. lamp will keep lighting for thirteen hours for one penny."

In our opinion it is altogether bad to make statements of this kind. Ignorant people fasten on them, especially as the ordinary newspaper sub-editor revels in giving them a corner, and thus hundreds, if not thousands, are led to expect something altogether impossible in the majority of cases. We do not say that it is impossible here and there to produce electrical energy so that it may be sold at three-halfpence per unit, but we do say that in the majority of cases at the present time it cannot be done, and there is no likelihood of its being done during the lifetime of this generation. It is the average cost and the average selling price that should be the guide, rather than the lowest possible cost and the lowest selling price under the most favourable conditions that can be obtained. It is extremely annoying for a canvasser who calls upon the householder to ask him to introduce the electric light to be met with questions about the exceedingly high price at which the company or the municipality he is canvassing for charge for the energy supplied. The canvasser is met with the statement that such-and-such an authority says the price to large towns ought to be three-halfpence per unit, and here you are charging threepence, fourpence, fivepence, sixpence, or more per unit. These charges may be low when all the conditions are taken into account, but the householder is not the person to trouble himself about the existing conditions. He merely thinks he ought to get it at a certain price, and is annoyed to think that he cannot get it at that price, and refuses to patronise the new light. The majority of towns in the British Isles are compelled to fall back upon steam or gas engines as the motor for driving the dynamos. They have no water power available, hence the cost of generating a unit of electricity will probably be much larger under these conditions than for a town where water power is handy and otherwise running to waste. A careful examination of the cost of generation in the stations of the companies and the municipalities, will show that in very few instances is the actual cost of generation below the selling price which Mr. Perry suggests; but there are other expenses to be met besides the absolute cost of generation, and, roughly speaking, the selling price should never average less than double the cost of generation. We venture to direct attention to this statement at once, in the hope that a general refutation of its possibility will do something to ward off the harm that such a statement might lead to if left unnoticed. It will be recognised that the whole of this paper is, as we have previously said, more to give a general idea of the elementary knowledge required by municipal officers who have to report to their various authorities, rather than to exhaust any one particular point of the subject; and in this we think Mr. Perry is right—that most of his colleagues will be glad to have such a paper for consultation when examining this subject.

THE ANNUAL MEETING OF THE VERBAND DEUTSCHER ELEKTROTECHNIKER AT MUNICH.

(BY OUR SPECIAL CORRESPONDENT.)

(Continued from page 177.)

INTERVIEW WITH MR. OSKAR VON MILLER.

Mr. Oskar von Miller, at one time manager of the German Edison Company and of the Berliner Elektricitätswerke, who, as is known, was commissioned to manage the technical part of the electrical exhibition at Frankfort-on-the-Maine in 1891, and there organised the famous transmission of energy experiments, has made use of the satisfactory results of these trials for the utilisation of the hydraulic powers of his native country, and the visit to one of these works—the Isarwerke—was one of the most interesting parts of the programme of the electrical congress. Owing to his various interests in different parts of Germany his time and person were much in demand, and I did not succeed in getting an opportunity for a quiet talk with him until the last day of the meeting. I was glad, after hearing his descriptions of the Isar works and other large engineering undertakings, to find that he had still a new subject ready for discussion with me. Having got Mr. von Miller away from his numerous friends, I said:

"What do you consider, Mr. Miller, the most striking recent advance in electrical undertakings in Germany?'

He replied: "One of the most important advances concerning the administration management of late years has been, in my opinion, the rapid increase of the use of electric light and power in small villages. I have designed several such plants for villages with 1,000 to 3,000 inhabitants which have been most successful."

"But," I asked, "how does the cost to the villagers compare with other illuminants at their disposal?"

"The rates I have recommended are such that the light is about as cheap as the petroleum lamp, owing. of course, to the high rate which is paid for petroleum at present in Germany. At a village I have in my mind, where the light has been started some three years, the charge is £1 per annum per 16-c.p. lamp simultaneously used, and as many lamps burn only by turns, 10s. to 12s. per lamp installed; for the latter the current can be used continuously day and night. As water power is used in the generation of the current, the cost of production is not in proportion to the actual number of units used by any lamp."

"About what size is the village you refer to, Mr. Miller?"

"The first small village, where an almost general use of electric light and transmission of force is made in a progressive manner, is Fürstenfeld-Bruck. It has a population of 3,000 inhabitants, and the total number of lamps fixed is now about 2,000. Besides the lighting, there is in the village a good demand for motors, of which there are some 18 with 36 h.p. at present at work. For these the charge is also fixed by the ratio output of the motor, and not by the energy consumed. The charge per horse-power and year in the different villages varies according to the cost of installation of the hydraulic power and the size of the motor; on an average the charge is £6 and £7. 10s. per horse-power per annum. These charges place power at the disposal of the various small users at prices which could not be attempted by other agencies?"

"How does the annual balance-sheet justify the installation in the case you refer to?"

"The annual cost of upkeep, including interest and amortisation of the capital, was about £1,000. The annual revenue would be at the preceding term about £1,400 for 2,000 lamps fixed, and about 36 h.p., the work being, however, carried out and managed by the community. No profit is calculated, and instead, the charges for light and power paid by the inhabitants are subject to discount."

"In the annual cost of the supply can you give me some idea of the principal items and their relative amounts?"

"In the annual cost of the supply the items of expense for paying interest and amortisation are about £600 for working expenses—that is to say, management, maintenance, etc., £400."

"What is the usual method of financing these village

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installations in Germany, and to what extent are the local people interested in the success of the undertaking?"

"Usually, such small plants are erected and managed at the charge of the communities. There are, however, also several places—for instance, Schwandorf, Landsberg, and Tettnang—where private companies undertake the installation and administration of the work. The licenses they obtain run for a period of 30 years, with the obligation to supply the lighting of the streets at a specially cheap rate."

"What system of distribution do you usually adopt for village plants?"

"I have adopted, according to the quantity and distance of the power and the kind of consumption of current, the most different systems. At Cassel the system of alternating current and continuous current with accumulators is employed, there being a small distant power at disposal which must be accumulated to satisfy the consumption. In the Isar works I have employed three-phase alternating current, because there immense powers, requiring no accumulation, are chiefly supplied to factories, for which the three-phase alternating-current motor is of special advantage. For villages where use is made of a distant power for lighting and for small motors, I usually employ single-phase alternating current because of the simpler conductors."

"One more question I should like to ask you, Mr. Miller. What is your opinion as to the future influence of the Verband on the profession of electrical engineering?"

"The Verband will be able to produce very useful effects as representative of the general electrical interests as relates to the authorities. It will also obtain successes in technical views, if it occupies itself with common questions, and avoids as well as possible to interfere with individual interests of the members of the Verband. I set great value on the friendly, sociable relations of the electricians advanced by the annual meetings of the Verband."

THE ELECTRIC LIGHTING OF THE CITY OF LONDONDERRY.*

BY JOHN CHRISTIE, CITY ELECTRICAL ENGINEER.

The question of electricity supply, both for public and private lighting, is now becoming of so much importance to municipal engineers that when the author was asked to contribute something to this meeting of the association, he thought he could not do better than give you a brief description of our generating station, with details of the scheme as adopted here for the public lighting of this city. The idea of public lighting by electricity was first discussed by the Corporation so far back as March, 1888, but was allowed to drop. The matter was again brought up two years later, and it was then agreed to take out a provisional order under the Electric Lighting Act of 1882. In 1892 private companies made proposals to the Corporation, offering to lay down plant and run it under certain conditions. These proposals, however, the Corporation declined, and wisely determined to keep the monopoly of electrical supply under their own control. As the time wore on, and the Board of Trade required the Corporation to take some active steps in the matter if they wished to retain their powers, they, in September, 1892, called in Mr. H. W. Blake as consulting engineer to advise them on a scheme. The following year the Corporation finally decided to adopt a scheme for the public lighting of the city by means of arc lamps.

This scheme, prepared by Mr. Blake, was submitted to Dr. John Hopkinson, and on his approving of the specifications, tenders for the plant were invited by advertisement, accepted, and gone on with as soon as the permission had been granted by the Local Government Board to borrow the necessary estimated capital of £15,000. In the selection of a site for the station, the Corporation were particularly fortunate in obtaining on very favourable terms what had formerly been an old saw mill, situated in the Strand at a distance of some 700 yards from the centre of the city, having a frontage of 63ft. to that thoroughfare, and extending back 230ft. to the quay, and having an opening on to the river, thus affording every facility for storing our coal direct off the steamer, and also an ample supply of water for condensing purposes. On this site in the central portion there has been erected a substantial brick building, comprising engine-room and boiler-house, temporary gables being erected at each end, so that if any extensions are contemplated the buildings can be easily enlarged to accommodate the extra plant. The chimney stack, of handsome design, is octagonal in shape, 125ft. high and 5ft. in diameter, which is more than ample to suit any additional boilers that are ever likely to be required. At present there are only two boilers laid down. They were supplied by Penman, of Glasgow, and are of the Lancashire type, 26ft. long and 7ft. in diameter, constructed for a working pressure of 125lb. per square inch. They are well provided with all the usual mountings, mostly of Hopkinson's latest type. The feed-water arrangements comprise two duplex double direct acting pumps, each capable of supplying 900 gallons per hour against the maximum working pressure. The water is drawn from a storage-tank of some 20,000 gallons capacity, placed on the roof of the boiler-house, and supplied direct off the town mains. It can be delivered either direct or through the economiser, and all the steam and water pipes are in duplicate, in order to avoid as far as possible all risk of failure. The economiser is one of Messrs. Green's, and consists of 96 4in. tubes 9ft. long. It is placed on the main flue, being heated by the waste gases from the furnaces. Suitable by-pass flues and dampers are provided to regulate the temperature of the feed water or shut off the economiser altogether for cleaning or repairs.

To prevent the tubes from becoming covered with soot and thus reducing the efficiency of the apparatus, a small horizontal engine is provided, which by means of suitable gearing actuates a set of scrapers, which slowly traverse up and down the tubes, keeping their surfaces clean and free from soot. As we use nothing but Welsh steam coal we have comparatively little soot, and the scraper engine, run for an hour or two at the beginning of each run, is sufficient to maintain the temperature of the feed water well up to 200deg. F. The steam is conveyed to the engine-room by two lines of 9in. wrought-iron pipe, having 6in. branch pipes to each boiler; both lines are common to each engine, and they are all thickly coated with a non-conducting composition to prevent loss from radiation. The pipes are provided with drain-pipes and steam-traps. In the engine-room are placed along one side three vertical compound condensing engines of 150 i.h.p., made by a local firm of engineers, Messrs. Brown and Sons. The diameters of the cylinders are, high-pressure 11in., low-pressure 22in., and the stroke 18in. The average speed at which they are run is 145 revolutions per minute. Each engine has a jet condenser of its own placed under the floor of the engine-room, the air-pump being operated off a crank disc on the end of the shaft. The condensing water is supplied to each engine by a separate 4in. cast-iron pipe laid direct to the river, each pipe being fitted with a clack valve, rose head, and mud-box. A 9in. cast-iron pipe serves as a common discharge to all the engines. An auxiliary injection pipe off the town mains is provided to each engine to assist at starting if the tide is very low or a suction pipe gets choked. The speed of the engines is controlled by Hartnell's patent automatic expansion governor fitted on the crankshaft, which, by shifting the angle of advance of the high-pressure eccentric, varies the cut-off of the valve to suit the load. The distribution of steam is effected in the high-pressure cylinder by a piston valve, admitting the steam in the middle and exhausting at the outer edges, and in the low-pressure cylinder by an ordinary trick slide valve; by this arrangement the high-pressure piston gland is the only one which is subjected to the full working pressure. All the bearings are of ample size, and are provided with a suitable means to take up the wear. The flywheels are 8ft. in diameter and 24in. broad, and each weighs about three tons. By means of two 10in. leather belts, each engine drives two dynamos, placed on sliding rails one behind the other.

The dynamos are of the constant-current series type, made by Messrs. Siemens Bros. and Co., Limited, London. They are designed for an output of 10 amperes at 3,000 volts at 750 revolutions per minute. The machines have ring

* A paper read before the Incorporated Association of Municipal and County Engineers at Londonderry.

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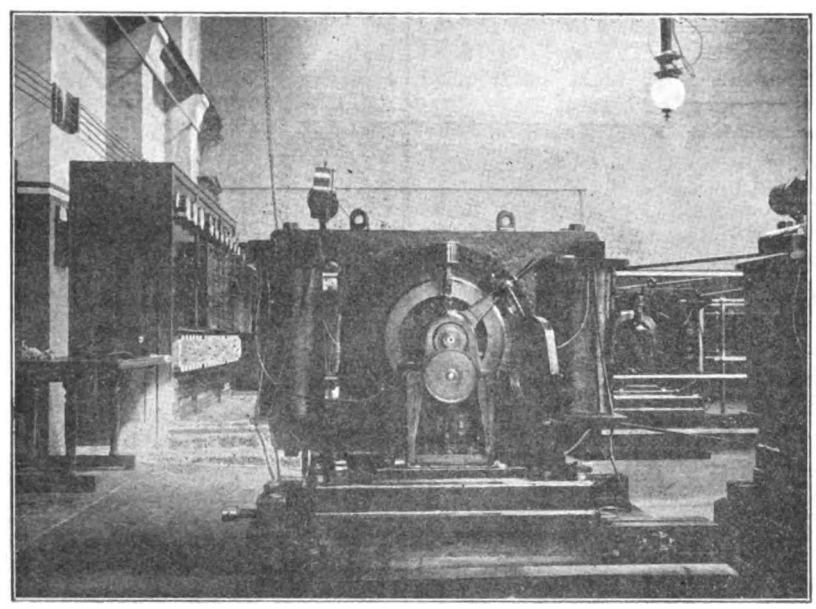
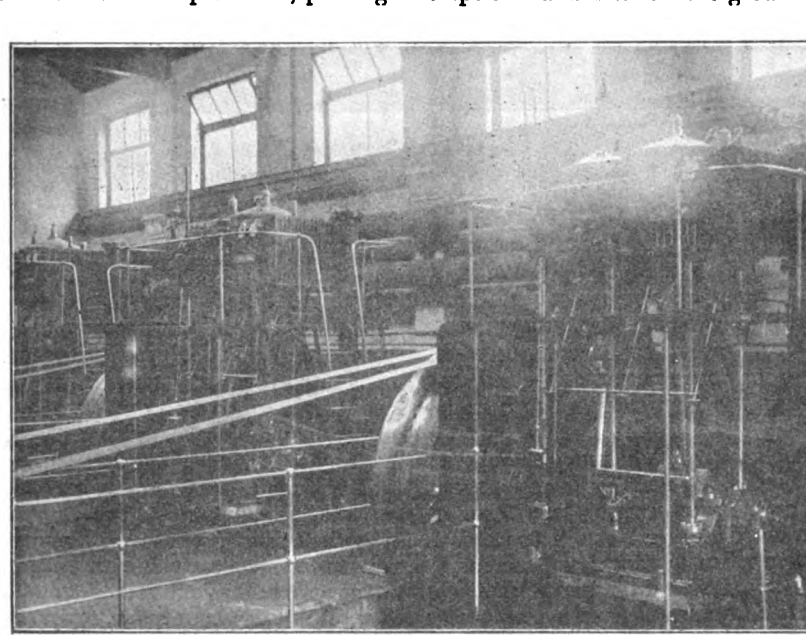
armatures rotating in a double magnetic field, and are fitted with copper commutators 18in. diameter, divided into segments, and insulated with mica. We have had them running constantly for nearly 18 months at 2,500 volts, and often having them subjected to the most severe strains possible—they have given no trouble whatever, the sparking is not excessive, and the wear on the commutators very small. To keep the current constant, a very ingenious regulator is provided, which automatically varies the voltage to suit the number of lamps on circuit by rocking the brushes back or forward; with these regulators in gear it is almost impossible to get more than 10 amperes for any time, and they give the current just as well on short-circuit as when the whole resistance of the circuit is on. Last winter we had ample opportunity of testing them through the high winds which were so prevalent, putting lamps to work temporarily, and also when two faults would sometimes come on the cables at one time, cutting out 10 or 20 lamps. From the dynamos the current is led to the switchboard by means of insulated cables laid in trenches under the engine-room floor. The switchboard, also made by Messrs. Siemens and Co., is composed of slate panels, in polished wood frames. It is arranged for six dynamos and four circuits, and is provided with short-circuit field switches, double-pole fuses, and a Swinburne electrostatic voltmeter to each dynamo; each circuit having a Siemens ammeter, double-pole fuses, and a Thomson-Houston lightning arrester on each end. By means of a plugboard any circuit can be run off any dynamo. The lighting of the city is divided into two sections, each section having two circuits with lamps arranged alternately on different circuits. At present we have the lamps arranged on the four circuits as follows: 40, 43, 41, and 48, or 172 in all; but extra lamps will most probably soon be looped in to bring the numbers on each circuit up to over 50, and do away with some more of the gas lamps which still exist in some of the smaller streets. The cables consist of $^{7}/_{16}$ copper strand heavily insulated with vulcanised indiarubber, served with a covering of bitumenised jute, armoured with galvanised steel wires, the whole being covered with jute steeped in a preservative compound and laid in the ground direct. The armouring is earthed at every lamp, and also at the station ends. There are some 34 miles of this cable laid, the longest circuit being about nine miles, and the area lighted is, I think, one of the largest in the country. During the first six months after the plant was taken over by the Corporation we had a most unfortunate time of it through failures of the lamp cut-outs, cables, and other causes incidental to the start of such a large scheme. For a long time this made the electric light most unpopular with many, but Messrs. Siemens successfully surmounted all the



View of Dynamos.



View of Dynamos, showing Automatic Constant-Current Regulator

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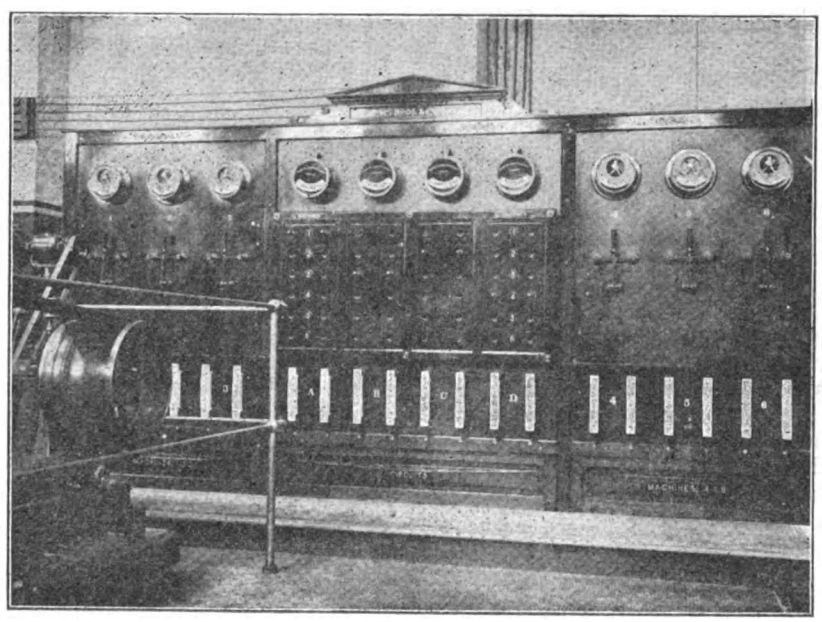
many difficulties as they cropped up, and in the very depth of winter entirely relaid the whole of the cables without interrupting the lighting of the city. All these failures are happily a thing of the past, and now we rarely have even a single lamp failure reported. All the lamps are of the well-known Brockie-Pell double-carbon 32-hour type, so that in winter they only require trimming every second day, whilst in summer once a week suffices. Each lamp has fitted within itself a cut-out, which, should the carbons burn out or the rods hang up from any cause, automatically cuts out the lamp from the circuit and forms a by-pass for the current to go on to the next lamp. The lamps are fixed on ornamental cast-iron pillars 25ft. high, and pitched from 75 to 250 yards apart. In the base of each pillar, inside a locked door, an isolating switch is provided, by means of which any separate lamp may be extinguished, quite independently of any of the others on the same circuit.

A brief description of our method of detecting faults on the circuits may be of interest to some of you. Daily insulation-resistance tests of all the circuits are taken, and if any one shows below the normal it is carefully watched; should it become dangerously low, the position of the fault is first roughly located by means of a Kelvin electrostatic voltmeter of the ordinary type reading up to 6,000 volts; the weights on the vane are adjusted so that the scale reads 50 volts per division. One terminal of the instrument is then earthed, and the other terminal connected to the positive and negative ends of the faulty circuit, and two readings obtained, which, assuming the voltage per lamp at 50, reads directly the number of lamps from either end, about which the fault exists. By referring to the map we can at once go to almost the exact lamp, and by freeing the ends at the switch tell by means of a detector whether the fault lies in a lamp or a section of the cable between two lamps. This method I find saves an immense deal of trouble, rendering it unnecessary to split up a long circuit into several parts until the faulty one is found; and if the readings are carefully taken we can always spot the section within two lamps either way. If the fault proves to be in a lamp it is immediately remedied by replacing it with a spare one, and if in the cable and of low enough resistance it is at the earliest opportunity burned out dead to earth by temporarily earthing one end of the line at the station, when by means of the loop test taken on the section with a portable testing set, the exact position of the fault is located and cut out. I am glad to say, however, that such faults never occur in the cable we now have through any inherent weakness of the insulation, but have always been clearly traceable to pick marks caused by some careless workman, when opening the streets, accidentally striking the cable and neglecting to report it.

The cost of the whole scheme up to the present amounts to between £18,000 or £19,000. The difference between this amount and what was first estimated is chiefly due to extensions of the scheme entered into after the contracts were settled. The end of our financial year is not up till November, and the author regrets that he cannot give you the exact cost of the public lighting. In winter during the long nights the works cost per lamp hour were as low as ·65d., and in summer, when the runs were shortest, they reached as high as 1·70d. per lamp hour. So far as can be judged, the total costs, including everything, should not much exceed £19 per lamp per annum, which, considering the number of hours we run (over 3,000), is by no means excessive. No attempt has yet been made by the Corporation to introduce private lighting, except in the Guildhall and clock, which are both lighted by lamps looped off the street mains, but as they have every facility on the site of the present station for the accommodation and working of all the necessary plant for private lighting, and as the town is particularly well situated for the working up of a most lucrative electricity supply business, the author has no doubt that before long they will be following the example set them by nearly all other leading municipalities, and wisely keep the valuable monopoly of supplying electricity to the citizens in their own hands by extending their present station and laying down suitable machinery.



View of Station Switchboard.

UNIPOLAR INDUCTION.*

BY REGIERUNGSRATH DR. C. L. WEBER.

An article by Prof. C. Arnold on alternating-current machines with stationary winding† is prefaced by some remarks on unipolar induction. The latter subject has also recently been elaborately treated by Prof. Lecher, of Innsbrück.‡

While Lecher, on the basis of experiments extending over many years, claims to have come to a definite conclusion as to the explanation of the phenomenon in question, Arnold admits that the majority of the appearances can be explained by the specific reciprocal results, but finally declares for those which Lecher does not deem to be trustworthy. For this reason a short consideration of the subject may be justifiable, for it must be puzzling to anyone who is not perfectly acquainted with the details of the question when, regarding a matter which crops up daily in practical work, two views of so fundamentally opposite a character are maintained.

The question is as follows: A cylindrical magnet revolves

* *Elektrotechnische Zeitschrift*, August 15, 1895.
† *Elektrotechnische Zeitschrift*, March 7, 1895.
‡ *Sitzungsberichte* der kaiserlichen Akademie der Wissenschaften zu Wien (Abtheilung II., Band 103, Heft 8, S. 949-980).

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on its geometrically coincident magnetic axis. Will the lines of force of the magnet rotate with it, or does the magnetic field stand still? The above-mentioned article by Lecher is without doubt the most careful and most elaborate investigation of the subject of unipolar induction which has been published in the last 10 years. As they cannot again be recorded here, it may be mentioned that Lecher repeated nearly all the experiments hitherto made bearing upon the question and critically examined them, finding thereby that in the case of all previous investigations the observations could be explained by both the one and the other theory.

Finally, the following experiments, which are to be considered as conclusive, were devised and carried out by him. A magnet excited by a fixed coil is divided into two parts, I. and II. (Fig. 1), which can individually be rotated on the axes, S N, S^1 N^1. Corresponding axle shafts are arranged at N S, N^1 S^1. At the same points, and also at *b* and *d*, are the sliding contacts, *a*, *b*, *c*, *d*, *e*, which can be connected with a galvanometer, G. The direction of the lines of force has to be conceived in the manner indicated. As is known, there flows, if both parts rotate together along a path, *a* G *b* or *a* G *c*, a current which, in the acceptation of a revolving field, can be imagined as having originated in the fixed galvanometer leads; in the supposition of a fixed field, in the rotating mantle surfaces and in the radial parts of the iron core. The following outcome of an experiment can also possibly be explained by both views. Only magnet II. revolves, the galvanometer being first at *c d*, next at *d e*. The issue in both cases is the same. It can here be taken with Faraday that in both instances the same amount of induction takes place in the actuated con-

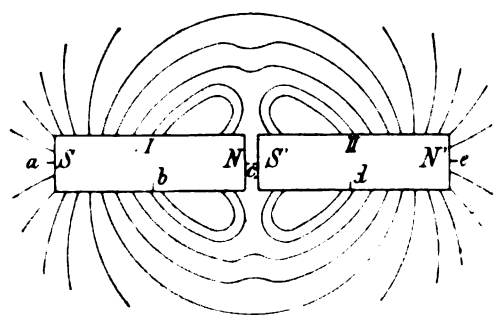

Fig. 1.

ducting parts of the magnet on the fixed field being cut, as, according to the other view, that the total of the E.M.F. induced in the two fixed circuits in both cases is the same. The course of the lines of force certainly causes the latter explanation to be considered with doubt, but the determination of this course is generally of an uncertain nature.

On the other hand, the observations about to be described cannot be brought into consonance with the theory of rotating lines of force. If Lecher altered the last mentioned experiment, so that not only magnet II., but also magnet I. revolved, either in the same direction as, or in the reverse direction to, II., the galvanometric results were the same as if I. were stationary. According to Faraday, this is immediately clear, since the magnetic field remains continually at rest and the actuated conductors connected with the galvanometer only belong to magnet II. The contrary happens if the lines of force revolve with the magnet; for then, if I. be set in motion, an influence of the galvanometer circuit, *c* G *d*, is perceptible, as the lines of force emanating from and actuated with I. reach into the circuit *c* G *d*.

Clearer is the following experiment: If *b c* is at the galvanometer and I. rotates while II. is stationary, exactly the same current is obtained if *b d* is at the galvanometer and I. again rotates, II. being stationary. If, however, both magnets are revolved in opposite directions, double the amount of current is the result.

Finally, Lecher connected the sliding contacts *a* and *e* with the galvanometer, so that the wires formed the extension of the magnetic axis. If, now, I. rotates alone, a current of 33 is obtained; if II. rotates alone, and in the contrary direction, the same result is attained; if both magnets are simultaneously revolved in the opposite direction the total of the two previous currents is the result.

Arnold has a new, but impossible, theory. He says: "It must be considered, if only the one magnet revolves, that then its lines of force rotate at only half-speed, and that generally the speed of the angle of the magnetic field does not correspond with that of the revolving iron mass, but that the rate of both is dependent upon the ratio of the actuated to the total iron mass."

If it be sought to follow this idea it will be necessary, in the first place, to at least look upon the lines of force flowing within the iron as bound to the iron and revolving at the same speed. Then, however, a variation of speed must occur at the point of exit, and therefore a tearing-off of each line of force and a sliding away of its termination at the magnet surface. Likewise must then at the place of

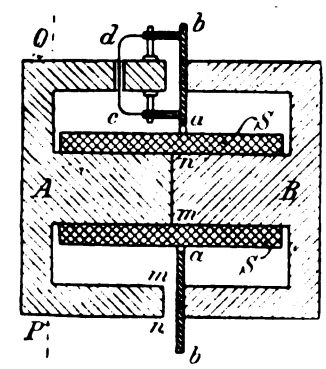

Fig. 2.

entry in the stationary or opposite rotating part of the magnet a similar inconstant point in the lines of force with the half angle speed glide over the surface of the iron. The lines of force in the various parts of the course must exhibit a triple phase: (1) within the iron they have the same speed as this; (2) outside of it they show the half, or generally another speed; (3) at the points of transition a sudden change in the speed occurs.

The idea of a stationary field with rotating iron core has nothing overstrained in it. The lines of force are comparable to a condition of the ether, which is influenced by the properties of the surrounding matter. If, however, neither the magnetic excitation nor the exciting capacity of the material alters in a given direction from point to

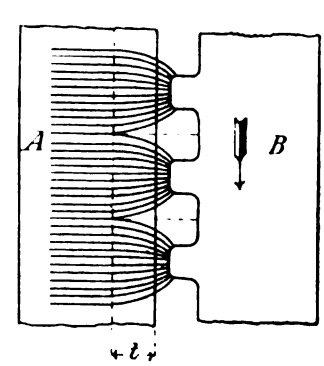

Fig. 3.

point, so will also the condition of the ether remain unchanged. A ground for a rotation of the field of force does not therefore exist with the rotation of a magnetic body, whose geometric, magnetic, and rotation axes coincide.

If we take two bell-shaped iron cores which are excited by a common coil and can rotate independently of each other, something, as in alternating-current machines, we find that between the two outer mantle surfaces gaps remain which can take up induced coils (Fig. 2). So long as the dividing surfaces run continuously throughout, the above considerations find application without further difficulty, and lead to the representation of a fixed magnetic field, by which, in simultaneously rotating parts of conductors (as, for example, in the disc *a b*), radial currents are induced; but if the dividing surfaces—in

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the first place on one side only—are not continuous (Fig. 3), the idea of the simultaneously rotating lines of force, shown as incorrect, again obtrudes itself. A little consideration, however, manifests that this theory is here quite unnecessary and liable to lead to error. This is best recognised by passing over to the next drawing, Fig. 4, where both surfaces are furnished with teeth. A is rotating and B is stationary; you fix an individual tooth in your eye and conceive that it on the rotation of position 1 pushes forward into position 2.

If here the lines of force rotate with the iron mass, equally as many lines of force should pass through this one tooth in position 1 as if it after a short time had reached 2. This will in reality in nowise be the case; we are rather shown that the tooth in question in position 2 on account of the large air-gap carries considerably fewer lines of force. The induction consequently which a coil placed on the tooth experiences proceeds here not from a rotation of the lines

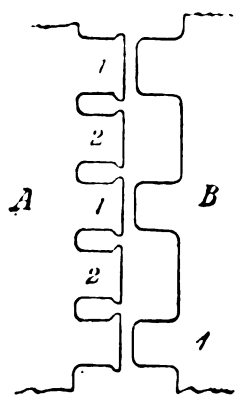

FIG. 4.

of force in the direction of the field, but from a fluctuation of the flow of force parallel to the rotating axis. The majority of the lines of force produced will now take their way through the one tooth, now through the other, accordingly as the one or the other path offers at the moment the least amount of resistance. The theory that here the lines of force should rotate at half-speed is obviously upon this hypothesis not feasible.

For the estimation of the eddy currents set up, and of the magnetisation energy, and for the selection and arrangement of the means to be used for the avoidance of these losses, it is a point of great importance whether in machines of the last-named form a side by-pass of the lines of force or a deviation in the direction of the rotating axis is presupposed. If you, in the last-mentioned case, look upon the actuated part somewhat as the field magnet of an alternating-current machine, the fluctuations mentioned will pass for armature reaction.

ELECTRICAL MACHINERY FOR MINES.

A meeting of the Midland Institute of Mechanical Engineers has been held at Barnsley, at which Mr. Rankin Kennedy read a paper on "Electrical Machinery for Mines," in the course of which he discussed the relative merits of continuous and alternating current motors. Owing to the liability to sparking, it was necessary to have continuous-current plants in workings boxed in airtight cases to prevent gas being ignited by the sparks at the brushes. The alternating-current system, if ever used, would undoubtedly be a polyphase system, in which polyphase alternators, with continuous-current exciters, would be used for generating the currents in two or three phases. The motors would be without commutators or brushes, and, being sparkless, would not require to be enclosed. In this system the pressures were not fixed, and any pressure desired, high or low, could be obtained with certainty and efficiency by a transformer. These statements sounded as if an ideal system had been reached, and theoretically it was all right, but in practice it had not reached the theoretical limits, as the generators were more costly than continuous-current generators. The necessity for separate continuous current exciters was a serious drawback, and the motors at present available were more costly than enclosed continuous-current motors. Polyphase motors required sliding contacts and brushes to be inserted as resistances when starting. So long as a sliding contact remained the motor was no better than a continuous-current motor. It was possible to make the system a success, both electrically and commercially, and in time, no doubt, the various drawbacks would be overcome. Considering polyphase motors fuse in mines where gas accumulates, he said that where motors of less than 15 h.p. were required the Kennedy polyphase motor could be used successfully without sliding contacts, and could be applied to the working of pumps and coal-cutting and haulage machinery underground with perfect safety, and for larger powers the same motor might still be used without sliding contacts if allowed to start under a small load by using a friction clutch or fast-and-loose pulley. The chief difference between this and other polyphase motors was that the two currents were quite separate on the motor, and mutually protected each other. In the combined system the author proposed to use a modified continuous-current generator, capable of supplying continuous current and polyphase currents simultaneously, it being possible to make a generator capable of supplying continuous, alternating, and polyphase currents as simple, cheap, efficient, and reliable as the continuous-current dynamo, being, in fact, the same machine with a few simple modifications. These would give 90 per cent. of efficiency, and would be a great advantage in the use of electric light or power in connection with collieries.

THE FIRST BRITISH ELECTRIC MOUNTAIN RAILWAY.

A Douglas correspondent, writing on Wednesday, says that on that day, in the opening of the Snaefell Mountain Railway in the Isle of Man, there was completed an engineering work of considerable magnitude and importance. The railway commences at the village of Laxey, seven miles from Douglas, and terminates on the summit of Snaefell, at a height of 2,000ft. above sea level. The total length of the line is 4¾ miles. The actual height ascended is 1,820ft., making the ruling gradient 1 in 12. The gauge is 3ft. 6in., and the line is double throughout the entire length. The carrying rails are of steel, and weigh 50lb. to the yard. A centre rail, known as the "Fell System," has been adopted to ensure absolute safety to the descending trains. It is a double-headed rail, weighing 65lb. to the yard. The rail is carried on wrought-steel chairs, to which it is bolted. The chairs are fastened to the cross sleepers by four fang bolts, a chair being placed on every sleeper. The Fell system is also utilised for tractive purposes as well as for brake power. Horizontal wheels are driven by a separate motor, enabling heavier loads to be carried at a greater speed on steep inclines. This system was applied to the crossing of the Mont Cenis Pass of the Alps before the great tunnel was completed, and it has been successfully working in South America, and has also been adopted by the New Zealand Government for crossing mountain ranges. On leaving Laxey the line commences immediately to make the ascent, skirting the steep slopes of Laxey Glen. The picturesque little village of Laxey and the great wheel are seen from innumerable points of view, and they are not lost to sight until the train attains a height of more than 600ft. above the sea. At this point, on looking back through the Granane cutting, a lovely peep is obtained of the open sea, which is not again in view until it is seen on the opposite coast of the island. Now the heaviest and most costly portion of the work is reached, the line passing through a succession of cuttings through the rock and over high banks, supported by massive retaining walls. The ground is rocky and precipitous, and the Laxey river, which runs almost within a stone's throw, is several hundred feet below the line. At a distance of 2½ miles from Laxey the Snaefell mines are seen, directly on the opposite side of the valley, lying some 300ft. down in the hollow; and half a mile further the Snaefell Hut is reached, which has for some years served as a wayside hotel for travellers. Now we are on the mountain, and the line winds—always climbing—first round to the west side, whence Sulby Glen can be seen, then to the north, bringing Ramsey and the Point of Ayre into sight, then to the east, showing you Laxey again, and lastly to the south, where it terminates, having in a distance of 1¾ mile from the Hut made a complete circuit of the mountain. The line will be worked entirely with electricity as the motive power. The whole of the plant has been designed and constructed by Messrs. Mather and Platt, Limited, of Manchester. There are four Lancashire boilers, each 26ft. long and 6ft. 6in. in diameter, working at 120lb. pressure per square inch, and

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capable of giving steam sufficient for 700 h.p. There are five compound horizontal engines, and each independently drives a Mather and Platt dynamo. The dynamos supply the current at 500 volts pressure. The generating plant is erected in a station close to the line, about 2¾ miles from the Laxey terminus. At the latter place there is also a large accumulator station containing 246 cells of the patent chloride protected type. The accumulators absorb the spare current generated by the dynamos and distribute it to the line as the load requires. Messrs. Mather and Platt first introduced this system on the Douglas and Laxey Electric Tramway, where it has proved a great success, contributing largely to the economical and regular working of the line. It has also been adopted by them on the Stockholm and Djarsholm Electric Railway. The passenger cars are 35ft. in length, and will seat 48 passengers. The seats, which have movable backs, are placed transversely, so that the passengers may face the direction in which they are travelling. Each car is carried on two four-wheeled bogies. Each axle is driven by a Mather and Platt motor, capable of driving the car at a speed of eight or nine miles an hour on the ascending grade. Absolute safety is obtained against the cars leaving the rails. It would be an impossibility for the flanges of the carrying wheels to mount the bearing rail whilst the guide wheels are in play. A powerful centre-rail brake is fitted to each car, the action of which is to grip the centre rail itself. Whatever speed may be obtained in descending, no danger can possibly arise, as the car can be stopped within a few seconds from the brake being applied. The works were commenced in January last, and, considering the severity of the weather during the first three months of the year, and the amount of heavy rock-cutting that has had to be executed, they must have been pushed forward with the most resolute energy. The engineers to the undertaking are Mr. Alexander M'Kerrow and Mr. G. Noble Fell, of London, who have had much experience in the construction of mountain railways. Mr. Fell himself laid out the line, and has personally superintended the construction of the works; and Mr. R. N. Willis (for Messrs. Mather and Platt, Manchester) has had charge of the electrical department. During the opening day, though the weather was unfavourable and a thick mist prevailed, many tourists ascended the mountain by the railway. The cars ran with remarkable smoothness, and gave perfect satisfaction.

COMPANIES' MEETINGS AND REPORTS.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

An extraordinary meeting of this Company was held on Friday last, Mr. J. S. Forbes presiding.

The **Chairman** moved the confirmation of resolutions passed at an ordinary meeting held on July 29, to the effect that the articles of association be altered so that the amount from time to time declared by the Board as available for dividend be applied in such a way that there should be first set aside a sum equal to a preferential cumulative dividend of 7 per cent. per annum on the aggregate amount for the time being paid or credited on the "A" shares, and that out of the sum so set aside there should be paid a preferential cumulative dividend at the rate of 5 per cent. per annum paid on the amounts paid or credited as paid on the "A" shares without distinction.

The motion was unanimously adopted.

BIRMINGHAM CENTRAL TRAMWAYS COMPANY.

The fou·teenth general meeting of shareholders in this Company was held on Wednesday, Mr. W. Neale, the new chairman of the Company in succession to Mr. Ebbsmith, presiding.

The balance sheet showed a working profit of £55,924, or £3,120 more than in the preceding year, and the **Chairman**, in moving the adoption of the report and the directors' recommendation for the payment of a dividend of 3 per cent. on the written-down capital of the Company—equal to 1½ per cent. on the subscribed capital—drew a distinction between the steam and cable sections as the profit-earning and the electric and horse sections as the unprofitable section of the Company's undertaking. The steam cars had run, he said, 50,544 miles more, and carried 610,508 more passengers, and earned £2,469 more than in 1893·4, whereas in almost every item of expenditure economies had been effected. Seven hundred and five pounds had been saved in fuel alone, mainly by the substitution of 12 new Kitson engines for old Beyer-Peacock engines, and the average consequent saving had been ¾d. per mile. The gross earnings of the steam department were £82,749 and the working expenses £48,348, leaving a profit of £35,351. The cable section showed still better results. The mileage was 743,805 miles, an increase on the year of 44 955 miles; the passengers carried, 6,842 538, an increase of 143,062; the earnings £36,744, an increase of £670; and the expenses £16,830, leaving the profit on the section £19,914. The electric department had run 138,925 miles, a decrease of 198 miles; carried 1,154,345 passengers, or 149,488 less than in the preceding year; the earnings were £9 093, a decrease of £641; and the expenditure was £10,828, involving a loss on the year's working of £1,735. The horse department had run 152,895 miles with tramcars and 552,164 with omnibuses, and carried respectively 1,320,344 and 2,973,983 passengers—in the former case a slight increase and in the latter a decrease. The omnibuses showed a decrease in receipts of £1,677, and the tramcars an increase of £313. The earnings of the two services amounted to £27,888, and the expenses to £25,494, leaving the profit only £2,394 The cost per working mile was—for steam 9 11d., horse traction 8 67d., cable 5 43d., and electricity 18·43d. The Chairman pointed out, with regard to the electric service, that it had been greatly disturbed by the severe weather of the last winter, and also by the disastrous fire which occurred during the year, and the directors hoped, by being able to purchase their batteries at a less cost and by other economies, to bring the section to a paying condition in a short time.

Mr. Ebbsmith added that it would not be a bad speculation for an electric tramway expert to relieve the Company of the section and guarantee them against any loss on it.

The **Chairman** pointed out that the cost of maintenance and renewal of way had been an unusually heavy charge during the year, especially on the steam routes, and as it had all been charged to revenue the divisible profit was made very small. A dividend of 3 per cent. would absorb £5,820, the dividend on 5 per cent. guaranteed stock £5 000, £10,000 was invested outside the Company on reserve fund, and £671 was left to be carried forward.

The report was adopted and the dividends recommended declared, and subsequently there was a long and somewhat acrimonious discussion on matters of policy between members of the "old Board" and the two new directors who joined it a year ago as the representatives of the Shareholders' Association.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.

The following is the report of the directors to be submitted to the shareholders at the fifth ordinary general annual meeting, to be held at the Cannon street Hotel, on Monday, the 26th inst., at 12 30 p.m.: The directors beg leave to submit herewith the accounts and balance-sheet for the years 1893 and 1894, but at the same time desire to point out that they are only responsible therefor as from November 21, 1894 (the date when the management of the Company's affairs was placed in their hands by the Court) to December 31 of the same year, or less than six weeks out of the two years. The receipts of the 12 months ended December 31, 1894 exceeded those of the previous year by £527. 17s. 1d. The receipts of the 12 months ended December 31, 1893, exceeded those of 1892 by £2,509 19s. 1d. The receipts per car mile for the year 1894 were 11·61d., against 11 90d. for 1893, and 13·47d. for 1892. The decrease is the result of the increased car mileage run on the electric sections. The average fare per passenger carried in the year 1894 was 1·43d., and in the year 1893 1·45d., as against 1·48d. in 1892. The total expenditure in the year shows an increase of £1,653. 5s. 2d. as compared with the year 1893, and the total expenditure for 1893 shows an increase of £2,294. 4s. 2d. as compared with 1892. These large additions to the expenditure have been largely caused by the policy of the late Board in consenting to the appointment of receivers and managers in May, 1893, one of whom was the chairman of the Company; £1,455. 3s 1d. has been received by these gentlemen for remuneration. No interest was in arrear at the time of the appointment, nor was there any real necessity for such proceedings, which it is believed were instigated for the express purpose of preventing the control of the Company's affairs passing into the hands of shareholders hostile to the previous administration The directors do not propose in this report to deal with the difficulties placed in the way of the Shareholders' Protection Committee before the retirement of the former Board could be brought about in June of last year, when on taking office the directors found themselves face to face with an application to break up and sell the undertaking, which meant wiping out the shareholders, both preference and ordinary alike. At this crisis, and believing as they did that the proceedings against the Company were not in the interest of the main body of the debenture-holders, but were likely to lead to results disastrous to both debenture-holders and shareholders, the directors determined, even at their own expense, to use every endeavour to preserve the undertaking, and after an important litigation succeeded in obtaining the judgment of Mr. Justice Kekewich, affirmed by the Court of Appeal in favour of the Company, and the discharge of the receivers and managers, and a declaration from the Court that the tramway was a public undertaking, and could not be broken up or sold in the same manner as an ordinary commercial concern, and that a receiver of the net earnings only could be appointed. As this decision affects tramways throughout the kingdom, its importance cannot be overestimated. In consequence of this reverse in the Chancery Division, the plaintiff in these proceedings commenced a further attack upon the Company in the Queen's Bench, but met with no better success, his action being stayed with costs by the Court of Appeal. Immediately on taking office, the directors resolved to commence an action for damages at the instance of the Company against Mr. Joseph Ebbsmith and Mr. Wain, the late chairman of the Company, in which £15,000 damages and other relief is claimed, and this action is being pressed to trial as rapidly as its important character will allow. Other proceedings have also been taken with a view to the recovery of money which the directors contend should never have been paid. In furtherance of the policy upon which they were elected, the directors repudiated on behalf of the Company the contract of February 26, 1892, and litigation with the Electric Construction Company, Limited, is now pending with reference thereto. This contract meant absolute ruin to the Company, and the directors are advised that it will not

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be enforced against the Company. The directors have had the reorganisation of the Company under their constant and careful consideration. They were of opinion that the traffic superintendent and the draughtsmen were both unnecessary, and their services were accordingly dispensed with. Mr. Alfred Dickinson has resigned his position, and Mr. J. J. Robins, who has had considerable experience both in tramway and electrical work, has been appointed in his place, and, apart from other considerations, these alterations will result in a substantial annual saving to the Company. The directors ever since their appointment have had great and arduous difficulties to cope with, but they are gradually being surmounted. Winding-up proceedings have been attempted and various efforts made to break up the Company, but the directors have up to the present successfully met and defeated all such endeavours. The directors also find that there is a great and pressing necessity to provide some new method of traction for those sections of the line which are now worked by steam engines, the license to use which expired during the *régime* of the former Board, but which has been renewed by the Board of Trade from time to time. The litigation with the Electric Construction Company, Limited, above referred to, has hitherto presented an insuperable difficulty in formulating any satisfactory scheme for improved traction, but so soon as that difficulty is disposed of the directors propose to formulate a scheme which they trust will meet the views of the Board of Trade and the local authorities, and which will, while assuring a return of the further capital invested, offer a reasonable prospect of a dividend to the present shareholders. The directors have decided to discontinue the goods traffic, which has always been a source of loss to the Company. The directors regret that, owing to the circumstances above indicated, they were unable to hold this year's annual meeting in March. It is therefore necessary for the shareholders to sanction the meeting being held this month, and for that purpose an extraordinary general meeting of the shareholders will be held at the same place ten minutes before the time appointed for the annual meeting. Those shareholders who are unable to attend these meetings, but desire to support the Board, will please sign and return both the enclosed proxy forms. Under the provisions of the Company's Act one of the directors, Mr. W. Somers L. Schuster, retires by rotation, and being eligible, offers himself for re-election. The auditors, Mr. Henry Spain and Mr. B. W. Hardcastle, retire, and offer themselves for re-election.

BALANCE-SHEET, DEC. 31, 1894.

Dr. Liabilities.	£ s. d.	£ s. d.
Nominal capital—Reduced ordinary stock	129,650 0 0	
8,658 preference shares, £10 each..	86,580 0 0	
	£216,230 0 0	
Capital issued—ordinary stock.....	129,650 0 0	
Less calls in arrear	2,004 7 3	
		127,645 12 9
7,600 preference shares, £10 called		76,000 0 0
5 per cent. debentures	49,830 0 0	
Interest thereon	4,775 7 6	
		54,605 7 6
Sundry creditors		10,699 4 8
Reserve and renewal		5,055 6 3
Net revenue account—Balance at December 31, 1892		1,798 8 1
Profit for year 1893	826 12 7	
Less loss for year 1894	165 1 4	
		661 11 3
		£276,465 10 6

Cr. Assets.	£ s. d.	£ s. d.
Construction—As at December 31, 1892	260,104 17 10	
Expended since	6,246 12 1	
		266,351 9 11
Parliamentary deposit by receivers and managers..		1,342 16 0
Provisional order		1,862 9 3
Horses		79 11 3
Stores on hand		889 19 5
Rates and assurance prepaid		246 17 3
Sundry debtors		346 16 4
Cash at bank and on hand		1,420 2 11
,, in hands of receiver		4,925 8 2
		£276,465 10 6

The accounts are audited by Messrs. Henry Spain and Basil W. Hardcastle, chartered accountants, London.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Thorne (Yorks.).—The Thorne Parish Council invite tenders for the lighting such part of the town of Thorne as is comprised in the lighting area from September 1, 1895, to April 30, 1896. Tenders to be sent in by 27th inst. to Mr. C. Waller, clerk.

Alexandria.—The municipal authorities of Alexandria, Egypt, invite applications by October 1, 1895, for the concession of the tramway lines from St. Catherine Place, through the outer boulevards, to the projected abattoirs at Mex, with a branch line. Security £E1,000.

Bedford.—The Urban Sanitary Authority invite tenders for the supply of vulcanised rubber cables, in accordance with the specification which can be obtained from Mr. T. S. Porter, clerk to the Authority, on payment of a fee of 5s. for each copy. Sealed tenders, endorsed "Electricity," to be delivered at his office not later than September 4.

Braila.—The Municipal Authorities of Braila, Roumania, invite tenders by October 2 for the construction and working of a system of electric tramways in the city. Provisional security, 10,000f. This contract was originally fixed for July 29. Tenders are further invited by the Municipal Authorities of Braila for the lighting of the city by electricity or by electricity and gas. Provisional security 10,000f.

Cowes.—Tenders are invited by the Urban District Council for laying down an electrical plant of sufficient capacity to keep burning at the same time 2,200 8-c.p. lamps, and also for public lighting and the laying of mains to accommodate 3,000 lights at the same time. The length of the road to be lighted is about a mile. Particulars can be obtained from Mr. Nelson F. Dennis, A.M.I.C.E., engineer to the Council, Cowes. Tenders are to be delivered by August 27.

Chepping Wycombe (Bucks.).—The Urban Sanitary Authority for this borough are prepared to receive tenders from public companies for working the electric order obtained by them within the borough for a term of years and upon approved conditions. Tenders are to be delivered by noon on October 14 next, at the office of the town clerk, High Wycombe, where a copy of the electric order may be seen and further particulars obtained. The Authority do not bind themselves to accept any tender.

Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

London, W.—The Hammersmith Vestry invite tenders for complete schemes for public and private lighting, and for the supply of motor power in that portion of the parish of Hammersmith described in the provisional order as the compulsory area. Memoranda of instructions, with a map of the district, may be obtained from Mr. H. Mair, surveyor to the Vestry, between the hours of nine and five, Saturdays nine and one, on payment of a deposit of £10, which will be returned to persons sending in a bona fide tender. Tenders are to be delivered at the meeting of the Vestry, at the Vestry Hall, at 6.30 p.m. on September 4.

Killarney.—The Commissioners for the Control of Lunatic Asylums, Custom House, Dublin, invite tenders for the electric wiring of the Killarney District Lunatic Asylum, the same to be connected to the supply mains (high tension) of the Killarney Electric Lighting Company. Forms of tender will be issued on application to the above Commissioners on deposit of £1, which will be returned to all persons who have sent in *bonâ fide* tenders on return of specification. The plans and specification can be seen at the asylum or at the office of the engineer, W. Leake, Esq., 30, Victoria-buildings, Manchester. Tenders are to be sent in by 30th inst.

Sunderland.—The Corporation invite tenders for (*a*) high-tension and low-tension concentric cables; (*b*) cast-iron pipes and box frames and covers; (*c*) stoneware casing, boxes, and bell-mouth protectors; (*d*) high-tension transformers for alternating current; (*e*) meters for alternating current. Specification, etc., can be obtained on payment of one guinea at the office of the borough electrical engineer, Electric Supply Station, Sunderland. The deposit will be refunded on receipt of the specification and conditions of contract with a *bonâ fide* tender. Tenders should be delivered at the town clerk's office by Monday, 26th inst.

Portsmouth.—Tenders are invited for wiring and lighting by electricity the police stations at Buckland, Southsea, Portsmouth, and Portsea. Full particulars can be obtained, and specifications can be seen, at the Town Hall, where a form of tender can also be obtained. Form of tender supplied to be completely filled in and sent under cover to Mr. Alexander Hellard, town clerk, by 3 p.m. on 27th inst. Form of tender must include a declaration that the person making the tender pays not less than the trade union rate of wages, and observes the hours of labour and conditions recognised and in practice obtained by the trade unionists in the borough.

Islington.—The Vestry are open to receive tenders for the wiring of the Vestry Hall and municipal offices in Upper-street, N., and for the supply of fittings. Specification, etc., can be obtained on application to the electrical engineer, Electricity Department, 50, Eden-grove, Holloway, N. Deposit of £1. 1s. will be required for the forms, but such deposit will be returned on receipt of a *bonâ fide* tender. The contractor whose tender is accepted will be required to pay his employés engaged on the work the trades' union rate of wages and observe trades' union conditions and hours of labour. He will also be required to enter into a contract and to find two sureties for the due execution of the work. Tenders must be sent in by 27th inst.

Wakefield.—The Corporation invite tenders for the supply and erection of the following: Section A—boiler-house plant (boilers and fittings, mechanical stokers and engine economiser, feed-pump, injector, etc.); Section B—engine-house plant (steam alternators, condensers, oil filter, fittings, etc., steam, exhaust, feed, blow-off, and sundry pipes, valves, and water-tank, etc.); Section C—main switchboard and instruments; Section D—underground work

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(cables, junction-boxes, culverts, and trenching, etc.); Section E—sub-station fittings (transformers and switchboard, etc.); Section F—arc lamps and posts; Section G—meters; and Section H—overhead crane. Particulars are obtainable from Mr. Robert Hammond, Ormond House, Great Trinity-lane, E.C., on payment of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders are to be delivered by August 24 (to-morrow).

Queenstown (Ireland).—Tenders are invited by the Queenstown Town Commissioners for the lighting of Queenstown by electricity (private as well as public) as per report and specification of Mr. R. Hammond, M.I.E.E., Ormond House, London. Tenders are also invited as follows: the contractor to provide the capital for the due erection of the works and maintenance thereof as per above plans and specifications, on being guaranteed the public lighting, and a stipulated number of private lights (to be agreed upon), the Commissioners having the right to purchase within a specified period. Plans and specifications are deposited at the Hall, Queenstown, and can be inspected there between 11 and 2. Tenders must be lodged with the town clerk, Queenstown, marked "Tender for Electric Lighting," by 2 p.m. on September 16. Further particulars and conditions to be had on application to Mr. James Ahern, town clerk, Queenstown.

RESULTS OF TENDERS.

York.—The City Council have been recommended by one of their committees to accept the tender (£8,650) of the Electric Construction Company for the supply of the first instalment of electric lighting plant.

Ilford.—The Council have accepted the tender of the Consolidated Telephone Construction and Maintenance Company, Limited, at £5 per annum for five years, for the provision of telephonic communication between the residences of the officers of the fire brigade, the stables, and the police station.

Lancaster.—Messrs. Drake and Gorham have been successful in obtaining the contract for the electric lighting of the Lancaster Infirmary with about 250 lights. The committee have also decided to place with the firm the work in connection with the electrical cooking, telephones, bells, speaking-tubes, and medical switchboards.

Walsall.—The Town Council have approved of the borough offices being lighted electrically, and that the tender of Messrs. Fallows and Wheatcroft be accepted for supplying and fixing the necessary fittings for the sum of £62. 10s. The tender of the Walsall Electrical Company, Limited, at £139. 5s. 6d., has been accepted by the Town Council for wiring, supplying, and fixing 82 incandescent lamps at the Town Hall.

Brighton.—The following tenders have been received by the Corporation for the supply and erection at the electricity works, North-road, of evaporative brass-tube surface condensers, electrically-driven air-pumps, exhaust and condenser piping:

Wright's Patent Heater Condenser Company, Westminster (accepted)	£2,476
E. Larsen, 19, Eastcheap, London	2,900
J. Fraser and Son, Millwall Boiler Works, London, E.	3,460

Bradford.—The following tenders have been accepted for the supply of best gas coal, cobbles, nuts, and cannel, for one or two years, commencing August 1, for the Gas and Electricity Supply Committee: J. Brown and Co., Limited, Atlas Works, Sheffield; Newton, Chambers, and Co., Limited, Thorncliffe Collieries, near Sheffield; Strafford Collieries Company, Limited, Barnsley; H. Briggs, Son, and Co., Limited, Whitwood Collieries, Normanton; Pope and Pearson, Limited, West Riding and Silkstone Collieries, Normanton; Locke and Co., St. John's Colliery, Normanton; Stanley Coal Company, Limited, Stanley Colliery, Liversedge; Barrow Hematite Steel Company, Limited, Barrow Collieries, Barnsley; West Yorkshire Iron and Coal Company, Limited, Leeds; Park Coal Company, Limited, Liversedge, *vid* Normanton; E. T. Ingham, Thornhill Collieries, Dewsbury; Liversedge Coal Company, Liversedge, *vid* Normanton; Mirfield Coal Company, Ravensthorpe, near Dewsbury; Lofthouse Colliery, Limited, near Wakefield; Crosland Coal Company, Limited, Scholes, Cleckheaton; W. Ackroyd and Bros., Limited, Morley Main Collieries, Morley; H. Ellison, Cleckheaton; J. and J. Charlesworth, Limited, Milnes House, Wakefield; Crawshaw and Warburton, Ridings Colliery, Dewsbury; Soothill Wood Colliery Company, Limited, Soothill Wood Colliery, Batley.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,753.

Midhurst (Sussex).—At a parish meeting a suggestion has been made that the electric light should be adopted.

House-Lighting.—The Tayler Smith Electric Company have been instructed to instal the electric light at 45, Ennismore-gardens, for Mrs. Goldsmid.

West India and Panama Telegraph Company.—The receipts for the half month ended August 15 were £1,649, as against £1,638 for the corresponding period.

The Brush Company.—The Brush Electrical Engineering Company, Limited, give notice that the debenture stock transfer-books of the Company will be closed till September 3.

Theatre-Lighting.—The Royalty Theatre, Dean-street, Soho, which has been closed for some time, will be re-opened early next month. In the interim the electric light has been introduced.

Brazil.—The Municipality of Itapecerica, Sao Paulo, propose to light that town by means of electricity, and have invited Dr. O'Connell Jersey, engineer, to submit plans and estimates for this purpose.

Donegal.—The Government have entered into negotiations for the purchase of the telegraph cable laid some years ago by Lloyd's Committee between Tory Island and the mainland of Donegal.

Mechanical Traction Syndicate, Limited.—This Company has been registered by H. Willett, 9, St. James's-square, Manchester, with a capital of £21,000, to construct and maintain any tramways or light railways.

Manufacturing Rights.—Messrs. Easton, Anderson, and Goolden, Limited, inform us that they have secured the sole rights for the manufacture of the "Niagara" crusher and pulveriser (W. H. Coward's patent).

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 18th inst. amounted to £1,374, as compared with £1,126 in the corresponding week of last year, being an increase of £248.

General Trades and Industrial Exhibition Company, Limited. This Company has been registered by John Dale and Co., Limited, Bridge-street, Bradford, with a capital of £5,000, to acquire the business of a promoter of exhibitions, etc., as hitherto carried on by E. Cox, of Birmingham, and to develop and extend the same.

City and South London Railway.—The returns for the week ended August 18 were £924, compared with £861 for the corresponding period of 1894, being an increase of £63. The total receipts for the half-year 1895 are £6,008, as compared with £6,063 for the corresponding period of 1894, being a decrease of £55.

Inyati Syndicate, Limited.—This Company has been registered by Cheston and Sons, 7, Great Winchester-street, E.C., with a capital of £15,000, to acquire any concessions or grants of land, mining, or other rights, etc., to construct and maintain rail or tram roads, or other public works, in Africa or elsewhere, and to turn to account the same.

Aberdeen.—On Monday evening one of the two new steam-engines, each of 200 h.p., which have been obtained in connection with the extension of electric lighting in Aberdeen, was turned on at the station in Cotton-street. Councillor Johnston, convener of the Gas and Electric Lighting Committee, was present, and switched on the dynamo. The engine, which worked very smoothly, and gave every satisfaction, was used to generate the current required during the evening.

Sunderland.—A report has been drawn up by the Highways Committee of the Sunderland Corporation with regard to the cost entailed by the introduction of the electric light into the town. It shows that up to June 30 the amount expended over the scheme was £20,961, and that there was further expenditure anticipated, bringing up the total to £22,987. 11s. 5d. It also shows that there has been a loss on the present year's working of £700. The committee have agreed to advise the Council to increase the electrical engineer's salary by £60 per annum.

Christchurch.—At a committee meeting of the whole Council Mr. Burt attended and explained a method for lighting the town by electricity. It was resolved, on the proposition of Alderman Druitt, seconded by Councillor Marshall, that the committee thank Mr. Burt for bringing the subject before the notice of the Council, and for the information he had given them. It was also unanimously resolved, on the proposition of Alderman Druitt, seconded by Councillor Green, "that the subject is one which deserves the closest attention of the Council, and that they consider the subject in the future, when further information has been obtained."

Leytonstone.—A meeting of the Wanstead Slip Ratepayers' Association has been held, Mr. W. Boddy presiding. The meeting protested against the decision of the Leyton District Council to introduce the electric light into the district; they did not require it. Mr. Boddy said the question of electric lighting had been before them some years. He believed the lighting of the public lamps, etc., cost the Council £3,000 a year at present, and it had been said that to instal the electric light in Leyton would cost £60,000, and that light would cost 50 per cent. more than gas. It was decided to send a deputation to wait upon the Leyton Urban Council on this and other matters.

Harbertonford.—Messrs. Churchward and Son's serge factory at Harbertonford was on Friday evening lighted by electricity. The installation was carried out by Mr. A. F. Lord, electrical engineer, Totnes, and a large company was invited to witness the switching on of the current. Two large switches control the dynamo and lamps These were manipulated by Mrs. Churchward and Mrs. Hoare, wives of the heads of the firm. The dynamo was manufactured by Messrs. Newton, of Taunton, and worked the 140 lamps with complete satisfaction. After the light had been turned on the company inspected the factory, and were unanimous in praise of the steadiness and purity of the light.

London County Council Loans.—The London County Council having reduced from 3¼ to 2¾ per cent. their rate of interest on loans to local authorities exceeding £10,000, the St. Pancras Vestry have agreed to borrow from the Council the sum of £75,000 for electric lighting and other purposes. The money is to be repaid in 42 years by 84 equal half-yearly instalments of principal and interest combined. By the reduction in the rate of interest the parish will save £8,396. The Vestry have received a cheque on account of the loan for £56,100, and the balance will be

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forthcoming when the officers of the Council have reported on the works for which the remainder of the loan is required.

Liverpool.—At the annual meeting of the Liverpool United Gaslight Company, which was held on Tuesday, Mr. Edward Lawrence, the chairman, said that the Corporation had lately taken a new start. They had purchased the electric lighting company, and therefore they might expect in due course that, so far as the Corporation was concerned, gas would be superseded by electric light, but he was very doubtful whether the Corporation would be able to persuade the public to take the more expensive illuminant any better than the electric lighting company had done. At all events, he could see nothing to make them feel that the property of the gas company was not as good as it had always been,

Electric Train Staff System.—The new electric train staff system has been successfully inaugurated on the Dungannon and Cookstown branch of the Great Northern Railway of Ireland, and the intervening sections between the Coalisland and Stewartstown Stations. By the new mode it is impossible for more than one train to be on a section at the same time, and this positively prevents collisions, as a train cannot enter a section until it is signalled clear from the next station, and the staff automatically given. The instruments, which are very intricate, were put up in the various cabins by Mr. Morris, the Government linesman, and at first trial worked without a hitch. The new system, which is also in operation from Dundalk to Derry and from Portadown to Omagh, will be extended to the Armagh and Newry branch.

Removal.—Messrs. Crompton and Co. are removing their electric heating department from 148, Brompton-road to Cornwall-buildings, 35, Queen Victoria-street, E.C. This step is necessitated by the increase of business and the desirability of being in a more accessible position for enquirers, who come from all parts of the country and abroad to see these new applications of electricity. The Brompton-road showrooms have answered the purpose of introducing electrically heated apparatus to the public and showing the possibility of its use, and after three years' experience the department has been placed on a permanent footing. From this date all enquiries should be sent to the new address, where Mr. H. J. Dowsing will be pleased to afford any information as to the various applications of electric heating. The showroom at Brompton-road will be kept open by the Kensington and Knightsbridge Electric Light Company for the benefit of their customers who may wish to see various applications of electricity.

Weybridge.—An adjourned public meeting on the lighting question has been held, at which Mr. Young moved, "That it is the opinion of this meeting of ratepayers of Weybridge that the lighting of the parish should be in the hands of the Urban Council." The Chairman asked whether Mr. Young meant to convey by his resolution that they should take over the electric lighting works, or that the matter should be left to the Urban Council to settle. Mr. Young said he meant that the works should be purchased. Mr. Palmer, who seconded Mr. Young's resolution, said he did not understand that that was the construction to be placed upon it. If it was in order he should move an amendment that that meeting of ratepayers, having confidence in their Council, should refer the whole question of the lighting of the district to their decision. The chairman accepted the amendment, which was then seconded by Mr. Benson, and carried. This closed the proceedings, and the decision of the question is still left to the Urban Council.

Bath.—At Monday's meeting of the Surveying Committee of the Town Council the report of the electric light inspector for the fortnight stated that experiments had been carried on by the manager as to the practical difference shown in the illumination by using different brands of carbon some of which were much superior to the rest. Those used on Saturday and Sunday nights produced a very fluctuating light, and it was probably due to this cause that five lamps were extinguished on Sunday night and one on Saturday night. There was a discussion on the character of the electric lighting, and Alderman Taylor moved that the electric lighting company be requested to give the illuminating power they had contracted to supply to the authority and discontinue explanations such as that sent on this and other occasions. Mr. Knight suggested that Alderman Taylor might put in the gas company. Alderman Taylor said no, because he was afraid they would go to the strict terms of their contract and supply 14-c p. lights instead of 16·32 c.p. The Chairman pointed out that the report was an explanation of their own officer. Alderman Taylor said it was not the kind of thing they wanted. The Chairman suggested that he should round off the corners of the motion a little, and Alderman Taylor then suggested that the clerk should be asked to write to the company that they did not want any more experiments at their expense. Mr. Mitchell, however, seconded the first proposal, which was carried unanimously.

Rhyl.—As the Rhyl Urban District Council felt in a difficulty as to giving consent to the construction of a tramway in Rhyl, it was decided to call a meeting of ratepayers and property owners. This gathering was held on Tuesday evening. Captain E. W. Keatinge, chairman of the Council, presided, and the Town Clerk explained that of three applications sent in for power to construct a tramway that of Mr. Chadwell, of Blackburn, had been recommended by the Road Committee of the Council for acceptance, gas being the motive power. Mr. T. C. Amos proposed that the meeting approve of the scheme, and adopt a system of tramways for Rhyl. Mr. Coxhead seconded, but objected to any system such as overhead electric wires, as the desire of Rhyl people was to clear away all obstructions on the promenade. Councillor Jos. Williams, amid some interruption, opposed the scheme as being dangerous to the large number of children who visited Rhyl. Mr. Lewis Jones questioned the chairman as to whether the Council had ascertained the cost of making and working the line, as Rhyl people did not want any more financial failures. Mr. Cheetham said that if the town adopted any system at all it should be one worked by electricity, and above all they should keep private companies out of the field. He proposed that the system be an electric one. Mr J. Morris seconded. Councillors P. Mostyn Williams and Elwy Williams, and the Rev. T. Shankland spoke against any tramway scheme, upon the ground that Rhyl was a pleasure resort, and the streets were too narrow and the distance too short from place to place; also that it would lower the tone of Rhyl, besides being dangerous to pedestrians. Mr. Abel Jones moved that the meeting should be adjourned in order that the lodging-house keepers, who were busy, might attend, and this was carried by a majority.

The Snaefell Electric Railway.—On Friday last Colonel Rich, of the Board of Trade, and Major Cardew inspected, on behalf of the Manx Government, the new Snaefell electric railway. The line extends a distance of 4¾ miles, with a continuous gradient of 1 in 12, from Laxey to the summit of Snaefell—over 2,000ft. above the sea-level. It is substantially constructed with solid embankments and heavy steel rails. There is a centre rail on which emergency grip brakes, which have been specially devised for the line, act. The inspectors carefully examined the line and the electrical equipment of the cars, and travelled in a car the whole length of the line and back. In descending the steepest incline at full speed the special emergency brakes were applied, with the remarkable result that the car, which was weighted to represent an ordinary load of passengers, was brought to a complete standstill in its own length. The retaining walls and embankments were examined by Major Cardew, and the engines and dynamos at the generating and accumulating stations were also inspected. Their exhaustive examination being finished, the inspectors expressed themselves as highly satisfied, and said they would report to the Lieutenant-Governor that the line was in perfect order for passenger traffic. At lunch afterwards, Mr. Hopkinson, of Manchester, proposed success to the undertaking, and Mr. A. Bruce, chairman of the company, responded. The engineers (Messrs. McKerrow and Fell) were present, as was Dr. Edward Hopkinson, on behalf of Messrs. Mather and Platt, who constructed the electrical plant. The whole line was built in six months, and all the overhead conductors were erected in 10 days. The line was opened for public traffic on Tuesday. There is now complete electrical communication between Douglas and the top of Snaefell—a distance of 12 miles. The Ramsey Licensing Court have by dint of Puritan influence declined to grant a seven days' license for the new hotel at the top of Snaefell. They have, however, managed to be so far judicious in granting a license for six days.]

Newport (Mon.).—The installation of the Town Hall at Newport with electricity has now been practically completed and the current switched on to the wires. A test was made on Monday night, in the presence of Alderman Moses, Alderman T. Jones, and Councillor G. Greenland, members of the Electric Lighting Committee, and those gentlemen, together with a few visitors, were all satisfied in the highest degree with the measure of success attained. The wiring and fitting of the building has been carried out by the Electric Installation Company, of Westminster, whose contract was £517, exclusive of some portion of the fittings. Every room, office, floor, and corridor has been connected, about seven miles of wire having been utilised in the work. The wires are doubled, so that if fuses go in any room, only one-half of the lights in the particular room will go out. The Council-chamber and the assembly-room have been most handsomely and artistically fitted. In all there are 425 lights throughout the establishment, including those in the police quarters, cells, etc. The turret clock was lit on Saturday by the new supply with 24 lights, there being six 16-c.p. lamps to illuminate each of the four dials. The work throughout reflects the greatest credit on the company with whom the contract was placed, and their foreman, Mr. Rixom. Almost all the places in the town connected are now supplied with the current. There has, unfortunately, been some delay with the new engines locally supplied for driving what is known as the night load—the heaviest load of all. The engines, so far, have not been got to govern quite as nicely as is desirable. Under the circumstances, and whilst the necessary alteration are being made to adjust the governors properly, the Corporation decided to get a set of small plant from the Messrs. Fowler, of Leeds, which was quickly placed in position, and is now running very smoothly. The arc lamps for street-lighting will, it is hoped, soon be placed up, and when the big engines have been got to govern properly, the town—or the central portions—will be lit by the new illuminant.

Taunton.—Mr. Harold W. Cousens, the electrical engineer to the Town Council, has reported to them that during the past quarter he had removed all the overhead wires in North Town and North-street, and that the underground cable had worked very satisfactorily, giving a uniformly high insulation resistance. He was carrying out the improvements and extensions recommended by Dr. Fleming in his last report, and the switchboard, ordered last month from Messrs. Newton, was in course of manufacture, and they were pushing on well with the work. It would, when erected, greatly aid in the efficient handling of the circuits. The lamp load was steadily increasing, as shown from the fact that they had added 73 16-c.p. lamps to the mains during the past quarter. The report of the Electric Lighting Committee was presented as follows: "Your committee have ordered that a cable be laid through the Crescent, as recommended by Dr. Fleming. Your committee herewith present the contract with Mr. Newton for supplying and fixing the switchboard, and they recommend that

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the common seal of the borough be affixed thereto. Your committee recommend that tenders be obtained for 1,000 tons of best Powell Duffryn coal, to be delivered as ordered from about December 1 next." Councillor Webber was surprised that such a little-used locality as the Crescent should be lighted by electricity, but he supposed it was owing to the fact that several members of the committee lived there. Councillor Potter replied that the committee were assured that certain residents would very probably take in the light if it was laid along the street. Alderman Stanfast thought the committee were going a little too fast, as he was surprised to find these extensions so rapidly carried out. If they were not careful, all the £3,000 just sanctioned would be spent in a very short time. He also complained of the uncertain character of the street lamps. He noticed that Bath-place was to receive attention, and he supposed it was to light up the darksome Conservative Club there. The report was adopted. The Finance Committee presented a number of accounts which they recommended for payment, including £888. 17s. 11d. on the electric light account, and £56. 8s. 1d. on the electric light loan account. The accounts were passed.

Harrow.—A special meeting of the District Council has been held, at which the clerk submitted a letter from the Board of Trade, dated August 2, forwarding for any observations the Council might wish to make a copy of a memorial they had received from certain ratepayers at Harrow, with reference to the proposed transfer of the Harrow Electric Lighting Order to the Harrow Electric Light and Power Company, Limited. It was moved by Dr. Williams and seconded by Mr. Hawkins that the Council make the following observations upon the memorial: "With regard to Clauses 5, 6, and 7 of the memorial, the new Urban District Council at its second meeting refused by five votes to four to pass a resolution interfering with the transfer of the provisional order. The clerk to the Council did not become solicitor to the company until after the resolution of January 14, in favour of the transfer to Messrs. Crompton and Hawtayne, was carried. His advice on the matter was not asked. The notice signed by Messrs. Crompton and Hawtayne was brought before the Council on July 8, 1895, and it was decided by five votes to two (two members not voting) to give directions to advertise and deposit the draft deed of transfer and submit to the Board of Trade for their approval With regard to paragraph 11, the draft deed of the transfer has already been submitted to the Council, and considered by them on two occasions—viz., at meetings on January 14 and July 8. With regard to the suggested additions to the draft deed, it appears to the Council that (*a*) is met by paragraph 17 of the draft deed of transfer, which precludes any subsequent transfer of the provisional order, except in the case of charges by the Council. It appears to the Council that (*b*) is met by Section 1 of the Electric Lighting Act of 1888, which enacts 'the grant of authority to any undertakers to supply electricity within any area where granted by license or by means of a provisional order to the local authority, or to any other company or person within the same area.' That copies of resolutions passed at the meetings of January 14 and July 8, 1895, be forwarded to the Board of Trade." On the motion being put, the chairman, Dr. Williams, and Mr. Hawkins voted for it, and Messrs. Clowes and Strange against it. It was therefore declared to be carried.

Canterbury.—At the last meeting of the Town Council Alderman Mason, in accordance with notice of motion, brought forward the subject of the electric light. He remarked that, seeing the previous negotiations had failed, and seeing the miserably inadequate light with which the city had recently been supplied, the time had now come when the Council should take some steps to acquire the electric light for the benefit of the citizens. He did not see why the matter should be shelved The Council had already gone to the expense of £400 to obtain their provisional order, and he thought they should now take some further steps in the matter. At some places the electric light was provided by the public authorities themselves with considerable benefit to the ratepayers, and he should be sorry to see Canterbury behindhand in this respect. He begged to move an instruction to the committee to consider the advisability of again advertising for the supply of electric light or taking steps to supply it themselves. Councillor Horsley seconded the motion. He quite agreed that the lighting of the city was not a credit to it. Without committing themselves to the form in which the light should be provided, he thought they should issue early instructions to the committee to proceed in the matter so that at an early Council meeting they might decide whether or not they were going to make use of the provisional order. Personally, he believed it was quite possible to work it by the power they already had. Replying to Councillor Harris, the Town Clerk said the negotiations with the Brush Company were at an end. By the order the Council could themselves undertake the lighting, or transfer their power to another company for a consideration. Alderman Hart said he did not quite see why Alderman Mason should censure the gas company, who would give the Council as much light as they liked if they would pay for it. With reference to the quality of the light, he reminded the Council that it was in their power at any time to test it. At the present time they supplied the city with from 14 c.p. to 16 c p At least, that was the report the directors had from their gas manager. As to electricity, he had not one word to say against that, as the Council were quite right to go forward, but he did not think the gas company should be censured. Alderman Sanderson said the quality of the gas on some occasions might be equal to that Alderman Hart had mentioned, but he must assert that they did not usually get what they wished to pay for, nor did they get a proper pressure. He quite endorsed what Alderman Mason had said. The time had come when they should seriously consider the matter. The Mayor thought it only right to mention that the citizens were very much indebted to the company for their liberality in illuminating the Westgate Towers so successfully during cricket week. The resolution was carried.

Electric Light at Brompton Hospital.—In the treatment of that terrible and mysterious disease, consumption, no precaution against contamination of air can be considered too great. If there is one thing more necessary for the consumptive patient than another it is, perhaps, that the air which he or she breathes should be absolutely pure Recognising this fact, the *City Press* says, the committee of the Brompton Hospital for Consumption and Diseases of the Chest have recently decided, after much deliberation, to light the whole of the hospital by electricity It is a bold step for a large hospital, mainly dependent upon voluntary contributions, to take, inasmuch as the cost of the installation, to say nothing of the increased expense of lighting, is very considerable. But the committee of the institution have come to the conclusion that the outlay is amply justified, bearing in mind the terrible nature of the disease which they have to cope with. If not the first, it is one of the first of the great London hospitals to adopt the electric lighting system, and there cannot be the least doubt that the change will conduce to the general welfare of the patients, who number upwards of 300. The hospital chapel has for some years past been lighted with electricity, the electric power being supplied by the House-to-House Electric Light Supply Company. Limited But now that it has been decided to light the hospital throughout in this manner the committee will provide their own installation Messrs. Laing, Wharton, and Down are the contractors, and it is expected that the installation—the work in connection with which has already been commenced—will be completed in about three months. The machinery is being fixed in the rear of the new extension buildings, and it will comprise a dynamo capable of running at 145 volts, a large battery of accumulators, and one of Messrs. Crossley's gas-engines. The lamps to be used are of the small incandescent type, and there will be 1 209 in all. There are some seventy wards to be lighted, together with the nurses' dormitories, the doctors' bedrooms an entertainment hall, and the administrative and other offices. The cost of lighting will, of course, be slightly higher, but the benefit derived by the patients will be considerable, and the committee and supporters of the institution are to be congratulated on the excellent example they have set. The hospital is the largest of its kind in the kingdom. The parent hospital has accommodation for 210 in-patients; and a large extension building, on the opposite side of the Fulham-road, providing 137 additional beds, was opened in 1882. The new building contains a spacious out-patients' department, and is fitted with every modern appliance which can conduce to the well-being and comfort of the inmates. Having in view the heavy outlay which this important extension has involved, as well as the serious increase in the annual expenses consequent on the occupation of the new building, the committee invite liberal aid by means of new subscriptions, donations, and legacies.

Brighton.—At the last meeting of the Town Council the Lighting Committee reported that they had had before them the following tenders for the supply and erection of exhaust-pipes, valves, etc, at the electricity generating station: Messrs. J. Fraser and Son, Millwall, £594; Messrs. Reed and Son, Brighton, £540; Mr J. Every, Lewes, £494 10s; Mr. H North, Brighton, £489; and resolved that the tender of Mr. H North be accepted. A letter from Councillor Dunk complaining of the inefficient lighting of Hanover-terrace was referred to the borough surveyor to report upon. With regard to tenders for the supply of condensers, etc., for the Corporation electricity works from Messrs. J. Fraser and Son, Millwall, £3 460; Mr. E. Larsen, 18, Eastcheap, London, £2,900; and Wright's Patent Heater Condenser Company, Westminster, £2,476, it was resolved that the tender of Wright's Patent Heater Condenser Company for the supply of evaporative brass tube surface condensers, electrically-driven air-pumps, and exhaust and condenser piping be accepted. Councillor Stafford having moved these proceedings, Councillor Greenyer asked whether, in putting up the standards for the electric light extensions on the east front, it would be necessary to disturb the asphalte again, and whether it would not have been better to have erected them when the cables were put in. Councillor Dell congratulated the committee upon having determined to give the town something for its money by erecting electric lamps in the Western road. He, however, asked whether the committee could not have done something towards illuminating the triumphal arch put up in the Queen's-road in connection with the Foresters' visit to Brighton; he supposed it was possible for the committee to put in the electric light for any such erection within 24 hours. Alderman Abbey said remonstrances had been made to him as to what the committee were doing on the Parade, and he assured the Council the greater number of the residents in the eastern portion of the town were in favour of the present improved system of gas illumination being retained. The argument he, however, had employed in response to those who had complained to him on the subject was that the cost of the electric light would be something about half the price of the gas now used, and he wished now to know from the chairman of the committee whether there was anything in that argument. Councillor Stafford, in reply to Councillor Greenyer, said they would, of course, have to disturb the asphalte in fixing the standards on the Parade, but if he went along the Western road he would see how expeditiously the work was being done there As to the remarks of Councillor Dell, they could, if necessary, connect the electric light to a building in the space of two hours; while, with respect to Alder-

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man Abbey's observations, although the cost of electricity might not be less by half than that of gas, it would undoubtedly be lower, and there would be an increase in the illumination. He was also sure that, as the result, the Marine-parade would be so beautifully lighted that when it was done the alderman would come to the Council and thank the committee.

Harrogate.—The Town Council have held a meeting at which the report of the General Purposes, Plans, etc., Committee was read. It ran: "(1) Electric Lighting Sub-Committee's report: The Electric Lighting Sub-Committee reported that they met on July 4: (*a*) as to Mr. Hammond's report—Mr. Hammond's report having been printed and sent to each member of the Council, the committee read through and considered the same, and it was resolved that the town clerk arrange with Mr. Hammond to attend a meeting of the General Purposes Committee at an early date to go through and explain certain portions of his report, and that Mr. Wilkinson be invited to attend the same meeting; (*b*) as to cables: resolved, that the British Insulated Wire Company be asked to supply cables for the low-tension system, in addition to the tender already accepted; resolved, that the report be approved and adopted. (2) Electric lighting: Mr. Hammond, consulting engineer, and Mr. Wilkinson attended the committee, and after reading Mr. Hammond's printed report they advised the committee thereon. (3) Turbines: resolved, that Parson's system of steam turbines be not adopted, but that a slow-speed flywheel alternator plant be adopted. (4) Boilers: resolved, that two Lancashire boilers, 30ft. by 8ft., be purchased. (5) Cables and conduit: resolved, that a double cable be adoptod and a 6in. conduit be laid to the gate leading to the farm. (6) Site of generating works: resolved, that the near site, that is on the north side of Oakbeck, as shown upon the plan, be adopted for the generating works. (7) Small plant: resolved, that a small daylight plant be also provided. (8) Junctions and meters: resolved, that in the first instance the sum of £800 be spent in providing junction-boxes and meters to 100 customers. (9) Revised specifications: resolved, that Mr. Wilkinson prepare a revised specification upon the basis of Mr. Hammond's report, incorporating the foregoing resolutions passed by the committee to-day." The Mayor moved the confirmation of the minutes. Alderman Hammond seconded, and the motion was carried. Councillor Scholes reported that along with Councillor Simpson he had visited the fire-tanks. Respecting the fire brigade and salvage corps bells the manager (Mr. Beaumont) said he had had considerable difficulty lately, not only with the fire brigade bells, but the electrical apparatus altogether. He said he had put on a stronger generator, and would try that for a time, and if not satisfactory then he would divide it into three separate circuits, and then he would guarantee it would be right. Since the generator had been put on the bells had rung satisfactorily. The Mayor remarked that it had been found that since the salvage corps had been connected the bells had not worked very well. A more satisfactory way to do would be not to mix up the two, but have two separate batteries. Councillor Scholes remarked that to do that they would have to duplicate the whole system. After further remarks the Mayor suggested that both matters be referred to the committee, and on the motion of Alderman Hammond, seconded by Councillor Hartley, this course was agreed to.

Yarmouth.—A meeting of the Town Council has been held at which the surveyor's monthly report on electric lighting stated that the expenditure for July amounted to £114. 11s. 5d., and the income to £102. 6s 8d., showing a loss of £12. 4s. 9d. The total loss on working for the half-year to June 30, as shown by the monthly reports, had been £164, but in consequence of an insufficient sum having been apportioned to the street-lighting, that was reduced somewhat; and after making allowances for some small items omitted from the expenditure account, the loss on the first six months' working might be definitely placed at £130, to which should be added the repayment of capital and interest. The mains in Broad and Market rows, Regent-street, and Market-place were now working up to their full load. That was not injuring cables, but might inconvenience customers. Some of the transformers were also fully loaded. He therefore advised that extensions of the mains provided for in the last loan should be proceeded with at once. It would take nearly three months to manufacture the large cables, which should be brought up from the central station by Southgates-road and South Quay to the Town Hall, and thence to some central point near the south end of the market, where a large transformer and sub-station should be put in so as to supplement the present cables, which were likely to be overloaded. There should also be some additional low-tension mains put in so as to reinforce the present low-tension network. He recommended that tenders be obtained for the cables and transformers, but that the work of trenching, laying, and making good should be performed by men in the employ of the Corporation. The arc lamps on St. Peter's-road being at work, he recommended that the gas lamps which they were intended to displace should be discontinued. He considered it desirable that a coal contract should be entered into which should extend over the winter up to midsummer of next year, by which time it was probable that the new coal stores would be ready to take in a much larger stock than could be accommodated at present. Ten meters were needed; cost, £45. The Electric Lighting Committee instructed the surveyor to consult with Mr. Preece as to the new mains suggested in his report, resolved to recommend the Council to have tenders obtained for the cables and transformers required, and instructed the borough surveyor to give notice to the gas company that the lamps in St Peter's-road would not be required after half-quarter day; to obtain tenders for supply of coal for the ensuing 10 months; and to purchase the meters asked for in his report. The surveyor estimated that the 11 lamps at the Fish Wharf would be alight about 800 hours during the ensuing season, and the cost would be about £50. Since the last meeting of the committee the customers had applied for 421 lamps, increasing the total number of customers to 99, for 5,122 lamps. A memorial from residents in Jubilee-place, Market-road South, for more light was referred to the Lamp Committee. Mr. H. Calver asked, by letter, that the gas lamp at the north end of Wellington-road might be allowed to remain, as the electric light at the corner of Napoleon-place did not illuminate the corner where the former was. The Sanitary Committee decided this matter should stand over.

The Rise in Copper.—During the last fortnight, the *Financial News* said on Saturday, the price of copper has risen about £1. 7s. 6d. per ton, and Chili bars were quoted yesterday at £46. 12s. 6d. per ton for cash and £47 per ton for three months forward delivery. Those who are usually best informed speak very confidently of a further rise in the metal, and the statistics appear to confirm their view. Both in June and July there were unusually large exports from the United States, and if the shipments from that quarter were to continue on the same scale we could scarcely expect that the visible supply of copper would remain within its present limits, and with the increase in the stock the price would naturally decline. But our information has been to the effect that the American exports would not be so large after the end of July, and the result of the first half of August bears it out. In June the arrivals of American copper at European ports amounted to 6,073 tons, and in July to 7,740 tons; but for the first 15 days of August they only reached 2,070 tons. If the arrivals during the latter half of August are not on a considerably larger scale, it is obvious that the month's supplies from the United States will be only slightly over 4,000 tons. And it seems more than probable that for some time to come the monthly supplies will not exceed this figure; for consumption has lately shown a great increase in the States, and we have it on the authority of the Government Geological Survey that no notable new discoveries of copper deposits were made last year, and that there were no indications of any sudden expansion of the producing capacity. The importance of the United States in the copper situation will be realised when we state that the world's total supply in 1894 was 319,391 tons, of which North America produced 175,290 tons. Assuming the Government report to be correct in saying that there are no indications of a sudden expansion in the country's producing capacity, and bearing in mind the increase in consumption that was noticeable in Europe last year, and has now extended to the States, the copper shipments from North America become a matter of the greatest interest. In 1894 the arrivals in Europe from the United States amounted to 71,480 tons, and in 1893 to 77,414 tons—far larger quantities than had ever been exported before. The extraordinary depression in both those years in the States probably accounted for the great increase in the shipments, and it is one of the best features in the situation that Europe was able to absorb so much American copper. It is generally believed that in normal times the United States could not spare more than 40,000 tons a year, at most, for export, and if we go back for a few years we find that the exports of American copper in 1892 were only 29,000 tons, in 1891 34,500 tons, in 1890 22,000 tons, and in 1889 32,000 tons. Now, if in the dull times of 1894 and the previous year Europe was able to take the large quantities of American copper that we have mentioned, it is a fair presumption, with a consensus of opinion that trade is improving, that Europe will want in 1895 at least as much copper as it did last year. Unless the United States can supply it, we do not know where the necessary quantity will be obtained, and, according to the July circular of one of the leading metal brokers of New York, the "large quantities due on contracts to American consumers will necessitate keeping the more copper here"—that is, in the States. There, thus seems to be good reason for believing that the stocks in Europe will not be supplied to the same extent as formerly by American copper, and as the deliveries during the first half of this month exceeded the supplies by 1,152 tons, a further rise in copper appears to be almost certain. It comes to this, that the only country from which we can draw supplies of unknown quantity is North America, and if she wants the metal for home consumption, and will not export it, we shall see the inevitable result, when the demand is greater than the supply, of higher prices; and we need hardly add that no company will profit more by the rise in copper than the Rio Tinto.

Ipswich.—A meeting of the Paving and Lighting Committee of the Town Council was held on Friday last, when the Town Clerk said some misapprehension existed as to what had been done by the County of London and Brush Provisional Electric Lighting Company. Mr. Paris called upon him and stated that he was sorry the application of the company for the approval by the Corporation of their application for a provisional order had not been considered. He (the town clerk) told Mr. Paris that the Corporation had not received any application for their approval, and after going into the matter Mr. Paris admitted that this was so. Both the secretary to the company and Mr. Paris had written on the assumption that the application had been made, whilst as a matter of fact it had not been made. All that he (the town clerk) had received had been the registered letter giving notice of intention to make the application. However, the company had plenty of time in which to take the next step. Mr. Paris said he assumed that he (the town clerk) would take his first application as the application for the assent of the Corporation, but his reply naturally was that if the company wanted the assent of the Corporation they must follow the proper form of application. He had received a letter from the engineer and manager of the

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company, Mr. A. J. Lawson, who wrote: "Mr. Paris has asked me to place officially before you the financial position of this company so that the same can be considered at the next meeting when the question of our application for a provisional order for Ipswich comes before the Municipal Council. The company was registered in 1891 as 'The County of London Electric Light Company,' and the name was changed in June, 1893, to the present name, but no capital was subscribed, with the exception of £1,000, until the beginning of 1895, when we issued a prospectus inviting applications for £200,000, all of which was taken up. In February of the present year a further issue was made of £130,000, so that at the present time the amount of capital subscribed is £330,000. Under our articles of association the company is empowered to issue £400,000 ordinary shares, £400,000 preference, and £400,000 in debentures, while among our largest shareholders are some of the most influential and important members of our banking and mercantile community of London. Our chairman is the Right Hon. D. R. Plunket, Q.C., M.P." The letter went on to state that the company practically own the whole of the shares in the Bournemouth, Richmond (Surrey), and Dover Electric Companies, and are interested in the Windermere and Scottish House-to-House Companies. Besides they are carrying out work in their own name in the London districts of St. Luke and Clerkenwell and Wandsworth. Mr. Lawson trusted the information would be sufficient to show that should the Council consent to the application for a provisional order they were dealing with a company amply able to carry the undertaking to a successful issue. The Town Clerk added that still the company did not make their formal application for the assent of the Corporation. He did not see that the information assisted the Corporation much, inasmuch as the company did not state what their liabilities were in respect to the undertakings they had mentioned, or what capital would be alloted to the Ipswich undertaking. He understood that the desire of the Council was to have the control of electric lighting in their own hands, and if anyone applied for an order they would oppose it. Mr. Pratt: At the same time, I don't think we can stand by and keep others out unless we show that our intention is really to proceed. Mr. Josselyn said he was inclined to think it would be better that electricity should be supplied by a private company. Mr. Churchman: I should like to see someone else burn their fingers over it. Mr. Josselyn said at all events it was not a matter for their committee to decide. It must come before the Council when the company made their application for approval. The matter then dropped.

The Copper Market.—Messrs James Lewis and Son, in their mid-monthly report on copper, write: Copper of all kinds has been in active request during the past fortnight, and a large business has been done in good merchantable, the price of which last week receded from £46. 5s. to £45. 1s. 3d. under pressure of the realisation of a considerable quantity bought during the excitement of three months ago and now falling due. On the conclusion of these sales values quickly reacted and have steadily advanced, until they close to-day (17th) at £46. 10s. for cash and £46. 17s. 6d. for three months, buyers, the advance since the 1st inst. being 15s. per ton. Three hundred and twenty-five tons of American bars and ingots have been shipped from here to New York, and further 200 tons follow. Several hundred tons of electrolytic copper have been sold back to the United States, and a quantity of Orford ingots are being returned from Havre. We hear also that English best selected has been sold for shipment thither; so long as prices with us keep below the parity of those ruling in New York we may expect these shipments to continue, and they will soon materially diminish the stocks held in Europe. In New York the price of Lake copper has advanced to 12 25 cents per pound. It is estimated that about 10,000 tons of various kinds of copper were sold during the month of July to American consumers for delivery during the last four months of the year. As a number of the smelting furnaces at Anaconda are being pulled down and rebuilt, the production of this company will fall off materially for some time. Out of 13 588 miles of street railroad existing in the United States, 10,363 miles are worked by electricity. Producers' returns are as follow:

	July.		Jan. to July.	
	1895.	1894.	1895.	1894.
European production	6,988	6,960	49,472	52,218
American production	12,524	12,639	83,136	86,590
,, imports	1,100	1,340	10,200	9,380
,, exports*	6,036	7,225	39,350	46,994

	Tons.
*United Kingdom	644
France	993
Germany, Holland, etc.	4,397
Mexico	2
	6,036

American exports for the first half of July are 1,910 tons. Stocks have decreased 752 tons, and the visible supply 1,271 tons during the past fortnight. Imports to date are 894 tons, and deliveries 3,601 tons greater than last year. The arrivals in England and France for the fortnight have been 3,657 tons, and the deliveries 4,409 tons. The arrivals of Chile in Liverpool and Swansea have been 900 tons and the deliveries 626 tons, and from other countries 2,011 and 2,527 tons fine respectively. The arrivals here and in Swansea from the United States have been 124 tons bars, seven tons ingots, and 80 tons matte, equal to about 171 tons fine, and in France 210 tons fine. The Chile charters for the past fortnight are advised as 1,000 tons, and exchange 17⅜d.

Stocks of Copper (tons fine)—	June 1. 1895.	July 1. 1895.	Aug. 1. 1895.	Aug. 16. 1895.
Chilian in Liverpool and Swansea	39,519	40,451	40,817	41,091
France	550	319	585	560
American in Liverpool & Swansea	3,437	3,598	3,157	2,517
France	907	702	762	682
Sundries in Liverpool and Swansea	996	4,231	4,605	4,729
London	4,398	4,172	3,557	3,177
France	154	209	234	209
Total	49,961	53,682	53,717	52,965
Afloat as advised by mail and cable to date –				
From Chile	3,486	3 833	3,221	2,702
From Australia	1,100	1,000	1,000	1,000
Total visible supply	54,547	58,515	57,938	56,667
Quotations—bars, per ton	£ s. d. 43 13 9	£ s. d. 42 7 6	£ s. d. 45 15 0	£ s. d. 45 10 0
Ore, per unit	8/6	8/3	9/	9/4½

Imports of Copper (excluding Pyrites and Precipitate to Outports) from January 1 to date:

	1893.	1894.	1895.
Chile into Liverpool and Swansea	9,840	10,901	11,312
America do.	15,010	19,220	11,906
Sundries into Liverpool and South Wales	17,978	16,554	21,754
Do. into London	6,909	6,584	8,646
	49,737	53,259	53,618
Chile into France	2,157	2,499	2,054
America do.	3,837	3,635	4,947
Mexico do.	2,530	4,497	3 850
Sundries do.	2,453	780	1,095
	10,977	11,411	11,946
	60,714	64,670	65,564
Deliveries do. in England and France	70,222	59,762	63,363

Worcester.—At the last meeting of the City Council, in submitting the report of the Electricity Committee, the Deputy-Mayor (Mr. G. H. Williamson) said it had come to his knowledge that a report was current in the city that he was, or had been, in some way interested in the British Electric Installation Company. If it were the fact that he was connected with any installation company in the city and at the same time occupied the chair of the Electricity Committee, he would be occupying a position which he was not at all entitled to—it would be very unfair and dishonourable. As a matter of fact, he had never had any interest whatever in that or any other electricity company either in Worcester or out of it at any time. He had neither lent them money nor supported them in any way. He did not know how the report had got so widely circulated, but he thought it his duty to take that opportunity of contradicting it. His work on the committee during the last 18 months had given him far more anxiety than his own business, or anything else he had been connected with, and he thought it quite enough to have that anxiety without having unfair reports circulated behind his back. Mr. Bozward remarked that they all agreed that Mr. Williamson was a gentleman of the highest honour and integrity, and that he would do nothing to compromise himself or the city. Mr. Williamson moved, and Alderman Ernest Day seconded, the adoption of a recommendation for the purchase of two water-meters for testing the evaporative power of the coal used at the generating station, at a cost, including fixing, of £33. In reply to Mr. Lewis, Mr. Williamson said such meters were used all over the country, and he believed they could be relied upon. Mr. Lewis: I am given to understand there is not a meter in existence that can be relied upon. The recommendation was adopted. The Council also agreed to a recommendation of the committee to accept the tender of Messrs Haynes Bros. for the construction of a pit for the weighing-machine at the generating station at £34. 15s. The committee recommended that the electrical engineer should be authorised to grant to each workman in his department one week's holiday per annum. In moving the adoption of the recommendation, the Deputy-Mayor said the stokers, engine-drivers, etc., at the generating station got one Sunday out of three. In order to do this on another Sunday they worked eight hours, and the other Sunday 16. The men did not have any Bank Holidays, and apart from one Sunday in three, they had no holidays at all. Their work was very close and arduous; the men had to be extremely careful what they were doing, and they could hardly expect them to keep in health if they had no opportunity of recruiting themselves. The Corporation paid the drivers the minimum trades union rate of wages—32s. a week—and they worked rather more than the usual number of hours. Some of the labourers worked as many as 84 hours per week. The proposal would cost £15 or £16, and he thought the money would be well spent. Mr. Chaplin seconded, remarking that the system proposed was adopted throughout the country, and he thought it would be an incentive to the workmen to do their work in the best possible manner. Mr. Lewis said there were men who had been employed at the cemetery from 10 to 20 years who had never had a day's holiday. Instead of only giving one class of men a holiday, they should consider whether the whole of the Corporation labourers should have it. The Sheriff supported the proposition, but sympathised with Mr. Lewis's suggestion that the whole subject should be considered. Mr. Winwood thought the whole matter should be referred back to the committee. The Corpora-

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tion wagoners had to be at work at six in the morning, and could not leave before six in the evening, and had no holiday except one day in the year when they went into the country. Mr. Lewis proposed, and Mr. Barnett seconded, that the matter should be referred back to the committee. Mr. Williamson said the adoption of the recommendation would give the workmen heart, and show that the Corporation sympathised with them. The workmen had a lot of very valuable property in their care, and any negligence on their part might cost the city hundreds of pounds. The amendment was lost, and the recommendation of the committee adopted.

PROVISIONAL PATENTS, 1895.

AUGUST 12.

15121. **An improvement in secondary batteries.** William Henry Willatt, 22, Jalland-street, Holderness-road, Hull.

15134. **Improvements in apparatus for covering electrical and other wires.** Charles William Washington, Market-place, Huddersfield.

15166. **Improvements in electrophores applicable as electric lighters.** Jean Henri Peletan and Edouard Christophe, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, 13th February, 1895, being date of application in France.

15174. **Improvements in single-phase and multiphase alternate-current motors.** Llewelyn Birchall Atkinson, 1, Queen Victoria-street, London.

AUGUST 13.

15178. **Improvements in electric arc lamps.** Edward Jesse Piper, 34, Victoria-street, Westminster.

15215. **Improvements in and pertaining to telegraphic and other printing apparatus.** Charles Luman Buckingham, 46, Lincoln's-inn-fields, London. (Complete specification.)

15216. **Improvements in electric lighting attachments for gas-burners.** Frank Alden Webb, 18, Buckingham-street, Strand, London. (Complete specification.)

15225. **Improvements in electric brakes.** James Devonshire 70, Chancery-lane, London. (William B. Potter, United States.) (Complete specification.)

AUGUST 14.

15259. **Improvements in and connected with dynamo-electric machinery.** Montague Sabor Pickstone, 4, Corporation-street, Manchester.

15260. **Improvements in electromagnetic separators.** Frederick George Robinson, 10, St. George's-crescent, Liverpool.

15276. **Improvements in self-recording electric meters.** Edwin Percival Allam, 49, Finsbury-pavement, London.

15288. **Improvements in electric clocks.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Société Anonyme La Précision, Belgium.)

15292. **Improvements in galvanic batteries.** Henry Tipping and John Blomfield Hamond, 19, Gloucester-place, Greenwich, London.

15295. **Improvements in the manufacture of illuminating bodies for use in electric lighting.** Emil Joseph Constam and Leon Gaster, 46, Lincoln's-inn-fields, London

15301. **Improvements in electric exploders.** Herbert Vivian Keeson, 40, Loudoun-road, St. John's Wood, London.

AUGUST 15.

15338. **Improvements in electric arc lamps.** Rowland Hill Barnett, Akenside-hill, Newcastle-on-Tyne.

15343. **Improvements in couplings or joints for the sheathing of electrical conductors.** Hugo Hirst, 73, St. Stephen's-road, Upton Park, London.

15363. **Improvements in electrical distribution.** Charles Ernest Spagnoletti, The Poplars, Aberdeen-place, London.

15365. **Improvements in and relating to electric switches.** William Henry Dingle and John Mackenzie Urquhart, 23, Bucklersbury, London. (Complete specification.)

15369. **Improvements in secondary or storage batteries.** Joseph Baxeres Torres, 17, St. Anne's-court, Wardour-street, London.

15371. **Improvements in and connected with primary batteries.** Walter Rowbotham, 45, Southampton-buildings, Chancery-lane, London.

AUGUST 16.

15431. **Improved electric apparatus for striking bells and the like or giving signals.** Denys Mathieu, 27, Martin's-lane, Cannon-street, London.

15432. **Improvements in or relating to batteries.** Denys Mathieu, 27, Martin's-lane, Cannon-street, London.

15433. **Improved electric apparatus for striking bells and the like or giving signals.** Denys Mathieu, 27, Martin's-lane, Cannon-street, London.

15442. **Improved means for supporting or suspending electroliers and the like, and for facilitating the raising and lowering of the same.** Harold Faraday, 11, Southampton-buildings, Chancery-lane, London.

15445. **Improvements in step-by-step printing telegraphs.** Walter Samuel Steljes, 24, Southampton-buildings, Chancery-lane, London.

15450. **Improvements in electric telegraphs.** Secondo Roos, Ferdinando Luraschi, and Ettore Luraschi, 45, Southampton-buildings, Chancery-lane, London.

15461. **Improvements in or relating to telephone receivers.** Stephen Henry Snowden, 37, Chancery-lane, London.

15470. **Improvements in asynchronous electrical machines.** Charles Denton Abel, 28, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour la Transmission de la Force par l'Electricité, France.)

15471. **Apparatus for converting alternating electrical currents into continuous currents.** Godfrey Bamberg, 28, Southampton-buildings, Chancery-lane, London.

AUGUST 17.

15511. **An improved hand-feed projector arc lamp.** James Brockie, 28, Southampton-buildings, Chancery-lane, London.

15513. **Automatic regulator for dynamo-electric machines supplying electric motors.** Alexander Donay, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1891.

11473. **Electromagnetic motors.** Lake. (Tesla.) (Second edition.)

1894.

14113. **Electric meters.** Cooper and others.

16916 **Lime and electric lights.** Taylor.

17378. **Direct-current transformers.** Blackburn and Boyden.

18177. **Electrically-actuated brakes, etc.** Auguste-Godchaux.

18196. **Electric conductors.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

18273. **Electric motors.** Imray. (Société Anonyme pour la Transmission de la Force par l'Electricité.)

21838. **Electrolysing chemical combinations, etc.** Bein.

1895.

9708. **Electric heaters.** Delany.

12229. **Electric resistances.** Voigt and Haeffner.

12420. **Electric battery plates.** Weise.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5⅝
Brush Company, Ordinary	3	2-2¼
—— Nom. Cum., 6 per cent. Pref.	2	2-2¼
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5¼-5⅜ xd
Chatham and Rochester	—	—
Chelsea Electricity Company	—	6¾-7¼
City of London, Ordinary	10	14¾-15¼
—— 6 per cent. Cumulative Pref.	10	15¾-16¼
—— 5 per cent. Debenture Stock	100	131-134
City and South London Railway, Consolidated Ordinary	100	41-43 xd
—— 4 per cent. Debenture Stock	100	133-135
—— 5 per cent. Pref. Shares	10	14-15 xd
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1-2
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A 1-200 of £50	100	—
Electric Construction, Limited	2	¾-1
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	2-2¼
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	1-1⅛
Fowler-Waring Cables	5	⅞-1
W. T. Henley's Telegraph Works, Ordinary	10	11-11¼
—— 7 per cent. Preference	10	15-15¼
—— 4½ per cent. Debentures	100	106-109
House-to-House Company, Ordinary	5	3¾-4
—— 7 per cent. Preference	5	7¼-7½
India Rubber and Gutta Percha Works	10	19-21
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7-7¼
—— 6 per cent. Pref.	5	7-7¼
Liverpool Electric Supply, Ordinary	5	7⅞-8⅛
—— Pref.	—	—
Liverpool Overhead Railway	10	10¾-10¾ xd
—— 5 per cent. Pref.	10	15-15½ xd
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	¼-½
Metropolitan Electric Supply	10	11-11½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-119
National Telephone, Ordinary	5	5¾-6⅛ xd
—— 6 per cent. Cum. First Pref.	10	16-18 xd
—— 6 per cent. Cum. Second Pref.	10	15-16 xd
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½ xd
—— 3½ per cent. Deb. Stock	100	106-108
Notting Hill Company	10	8½-9
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	5	7½-7¾
—— £4½ shares	4½	6-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8½-8¾
—— 7 per cent. Pref.	5	9-10
Swan United Ordinary	3	2-2½ xd
—— 4½ per cent. Debentures	100	104-107
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4⅜-4⅝
Westminster Electric Supply, Ordinary	5	8¼-8½
Yorkshire House-to-House	5	5¼-5½

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NOTES.

Train-Lighting.—Electric lighting for railway carriages, which has for some time been in use on a few of the leading Russian railways, is now, it is said, to be adopted for the express and mail trains on them all.

Industrial Premiums.—The Italian Minister of Agriculture and Commerce offers for competition, up to December 31, 1895, a large number of medals and diplomas for various industrial and art work, including an electrical long-distance power-transmission plant.

Incandescent Lamps.—Among the novelties in electric incandescent lamps is a lamp with a mirror placed inside the globe. The mirror throws the light out from the base in the direction the light is required. An inventor of Florence, Italy, is the originator of this novelty.

Motors for Horseless Carriages.—In answer to Mr. Macdona, Mr. Chaplin has stated in the House of Commons that the subject of motors for horseless carriages is one to which his attention has been drawn, and it is his intention to carefully consider it in connection with the Bill which was introduced last session by his predecessor.

Books Received.—We have received a copy of a treatise on "Experiments with a New Polarising Photo-Chronograph Applied to the Measurement of the Velocity of Projectiles," by Dr. A. C. Crehore and Dr. G. O. Squier (Artillery School Press, Fort Monroe, Virginia, U.S.A.); and the "Programme of Technological Examinations" held under the auspices of the City and Guilds of London Institute (Whittaker and Co., 10d.).

The Americans Again.—Weeds along railway tracks in the United States are now said to be killed by the "electric weed killer." It consists of a car carrying a dynamo, which sends a heavy current into a sort of rake of fine wires dragging among the weeds on each side of the track. As the wires touch them the weeds are "electrocuted" down to their smallest rootlets. It is proposed to introduce the same system in farming.

Telegraphy in Russia.—Vice-Consul Cooke, of Archangel, reports to the Foreign Office that the existing telegraph lines from Archangel to Kem are to be continued all along the White Sea littoral and the Murman to Vadsö and Vardö. The wires now in course of erection from Mezen to Ust-tsilma, the centre of administration of the Petchoro districts, will thus in another way bring the great outlying regions in touch with Archangel and with the world.

The Companies' Acts.—Sir Albert Rollit on Tuesday asked in the House of Commons whether the Government intended to adopt the draft Bill suggested by the Companies' Act (Amendment) Committee appointed by the Board of Trade with a view to securing early legislation on the subject. Mr. Ritchie replied that the whole matter was under his careful consideration, and he felt sure his hon. friend would see that it was impossible for him to make any announcement at present.

The Telephone Service.—On Tuesday in the House of Commons, Mr. Hanbury, in reply to Mr. M. Healy, said that, without expressing any opinion on the subject at present, the Government would carry out the recommendation of the late committee by reappointing a committee next session to consider and report upon the evidence already given on the conditions of the telephone service and the terms of the license between the National Telephone Committee and the Post Office Department.

The New Brussels Electric Tramcar is attracting a good deal of attention in Belgium. It is of such a size that the Brussels people call its type mastodonic. It is of open construction, has nine transverse rows of seats, with a total accommodation for 50 people; is run by its own dynamos; and is curved at both ends in order to avoid fouling at tangents. The Compagnie des Tramways Bruxellois is responsible for the introduction of the new car, which is claimed to be the first of its kind in Europe.

North-East Coast Institution.—Part IX. of vol. xi. of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders to hand contains Mr. Henry Foster's reply to the discussion on his paper, "On the Application of the Electric Arc to Machinery and Boiler Repairs, etc."; the adjourned discussion on Mr. S. O. Kendall's paper on "Turret-Deck Cargo Steamers," and Mr. Kendall's reply; and the adjourned discussion on Mr. G. H. Baines's paper on "The Metric System of Weights and Measures," etc., and Mr. Baines's reply.

Copper in New South Wales.—The copper lodes in New South Wales were first opened in 1858, since which time many thousands of tons of copper ore have been obtained. The cupriferous district covers an area equal to about 4,296,320 acres; but there are enormous tracts of country the exploration of which will increase the area. The most important copper mine in the colony at the present time is the Great Cobar Mine, and it is also the most distant from the seaboard, being 497 miles west of Sydney. The value of the copper raised in the colony and exported to the end of 1894 was £6,343,044.

Electricity in Convents.—Electricity is getting on in Italy. The Sacra Congregazione dei Vescovi, of Rome, having been consulted as to the propriety of installing the telephone in a convent, has replied that there might be no objection to the introduction of the instrument provided that it be used solely in "grave circumstances," and that two sisters are present during the communication. And with regard to the electric light, the same sacerdotal body is of the opinion that it may also be employed except at very important religious ceremonies, when candles only must be utilised. So says the Milan journal *L'Elettricità*.

Berlin Industrial Exhibition.—The German Consul-General has issued a copy of the programme of the industrial exhibition to be held in Berlin from May to October next year, of which Prince Friedrich Leopold of Prussia is the patron and Baron von Berlepsch, the Prussian Minister of Commerce, the honorary president. The exhibition will comprise 24 groups, among them being those for textile industries, clothing, building and engineering, wood, china and glass, metals, chemicals, food products, scientific and musical instruments, electricity, paper industries, leather, photography, education, fishing, shipping, and horticulture.

Queen's College, Ireland.—In the House of Commons on Saturday, speaking on the report of the vote for the Irish Board of Works buildings, Mr. Dillon said, with regard to the Queen's College, that there was an item in the vote of £2,500 for a chemical laboratory in Belfast. He did not object to that, but he thought it was unfair, considering that Galway received only £150, and Cork received nothing, although a laboratory was badly needed in the latter college. Mr. Hanbury, in reply, said that it was true that there was a charge for Belfast Queen's College, but none for Galway or Cork. That only applied to the present year. He had the figures relating to the total cost of the Queen's College.

Foreign Gas Journals.—The editor of the *Journal de l'Eclairage au Gaz*, commenting on the report of the electric

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lighting of Brussels, points out how poor the result is. Here is a station working to its full capacity and it can only make 3·64 per cent. to meet interest and sinking fund, while there is not a word about depreciation. The local conditions are all favourable, and yet this is all. The gas undertaking at the same time makes 8·2 per cent. on a capital of £720,000. The Geneva station has no dividend to declare, although it is worked entirely by water and pays no tax to the Municipality. The only way of making electricity pay, adds the editor, seems to be by running small local stations. He does not draw any inferences from the short time the electric works has been in operation, or from the fact that the gas consumption is not on the increase in Brussels.

The London and Paris Telephone.—On Tuesday last Mr. Henniker Heaton asked the Secretary to the Treasury, as representing the Postmaster-General, whether he could state the annual revenue and expenditure in connection with the telephone service between London and Paris; whether the telephone was used only or almost exclusively in business hours, and was idle for 16 hours out of the 24; and whether he could see his way to reduce the rate for three minutes' conversation. Mr. Hanbury said that the Postmaster-General regretted that he was not in a position to give the information asked for in the first paragraph, and the use of the telephone was by no means restricted to what were commonly called the business hours of the day. The rate was a subject of international agreement and the Postmaster-General did not see his way at present to propose any reduction.

An Aerial Railway. — Among the most recent projects for rapid transit is one by which the cars are suspended, and the motive power is electricity. As the centre of gravity is very low, derailment in this form of aerial railway is practically impossible. A road built on this plan has been designed by Herr Langen for Berlin and other places in Germany. A foreign journal says: "The system is adopted for ordinary rapid transit or high-speed service, it being claimed that a speed of 186 miles per hour can be attained. Friction plates prevent the derailment of the wheels, and they are secured to the motor case in the usual manner, the shocks being taken up by springs. The car is fastened to the motor in such a way by a centre pin as to permit of lateral play, and is suspended by springs, ensuring easy riding. Each truck has four wheels, and is provided with brakes, which take hold of the rail at top and bottom. Each car has two motors and seats 50 people."

Thermo-chemical Carbon Battery.—M. Korda, in *Compt. Rend.*, states that experiments made with a view to ascertain whether in the reduction of metallic oxides there is a development of electrical energy, show that only in two of the cases investigated is there any distinct E.M.F. Barium peroxide in contact with carbon heated at dull redness gives an E.M.F. of about one volt. Other peroxides, such as those of manganese and lead, show no similar behaviour, probably because the product of reduction is a conductor and forms short-circuits with the carbon. Copper peroxide and carbon, when separated by fused potassium carbonate, give an E.M.F. of 0·9 to 1·1 volt. If the potassium carbonate contains water, the current is at first in the opposite direction, but changes as the temperature rises. In both cases the E.M.F. is considerably lower than that calculated from the known thermal disturbances, and it follows that only part of the energy is liberated as electrical energy. Faraday's law is not applicable, because of the continuous supply of extraneous energy in the form of heat.

Electric Tramways in Germany. — The three members of the Berlin City Council who visited fourteen great European towns in order to examine the arrangements made for dealing with the traffic, recommend the underground conduit system of electric traction for the busier streets of the capital and the overhead conductor system for the less important thoroughfares and for those subject to floods. They also report that the transition from the overhead to the underground system can easily be effected when necessary; and, in contradistinction to some other opinions, that the Klette underground method of traction, as tentatively employed in Dresden, is a good one. A project for the construction of an electric railway from Brunswick (Braunschweig) to Wolfenbüttel has, furthermore, been presented to the authorities concerned. The Allgemeine overhead conductor system would be used; the line would be double-tracked to Richmond, thence single-tracked, and the 11 motors with their cars would attain a speed of from 12 to 15 English miles an hour. A peculiarity of the cars is that their seats would be removable to enable merchandise to be carried.

Belting.—The manufacture of electrical apparatus and the development of allied interests, have brought about many interesting changes of late years. In England the progress of the industry has been aided by and has aided the production of high-speed engines. In America, on the other hand, most of the dynamos have been belt-driven. In conjunction with this, what is said to be the largest belt in the world is that just furnished by the Jewell Belting Company. This belt is 118ft. long, 78in. wide, and four ply, and weighs considerably more than a ton and a half. It is now in use at a wire factory in Worcester, Mass., where the increased demand for electric wire has necessitated an increase in the power plant. The belt will be called upon, when running its full load, to transmit 2,000 h.p. It will be used to run nine mills, comprising at least two-thirds of the power consumed in the works. This belt has now been in use over a month, and is running as true and steady as an ordinary narrow single belt. It is worth noting that on the same day on which the Jewell Company received the order for this 78in. belt it also received an order for five 62in. three-ply belts for the Cincinnati Street Railway Company. If this is an average order in America, we shall expect our belt manufacturers to become strong opponents to high-speed engines.

Oskar von Miller on Overhead Conductors.—The well-known German electrical engineer, Herr Oskar von Miller, has recently given his opinion on the overhead-conductor system of electric tramways, especially in regard to its application in Nuremberg. According to the *Elektrotechnischer Anzeiger* of August 8, he concludes his remarks as follows: "It is my opinion that the Nuremberg Tramway Company is scarcely bound at present to introduce the working by accumulators or underground conduits in all streets, but the numerous improvements which may soon be expected in both systems will probably result in many cases in the discontinuance of the use of overhead conductors, while the possibility of doing away altogether with them is not very remote. I should therefore recommend that the Nuremberg Tramway Company be allowed, in the first place, to use overhead conductors in all streets, but that the clause which binds the company, on the expiry of six years, to remove the overhead conductors, when, in the opinion of a Court of Law, a new system of motive power, without overhead wires, has demonstrated its excellence, both from an electrical and viatectural point of view, be amended in that the tramway company will have, in the more important thoroughfares,

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within a fixed period, and without a decision of a Court of Law, to discontinue the use of overhead conductors."

The Proposed Derbyshire Electric Railway.—Further particulars are published regarding the light electric railway which it is proposed to construct between Derby and Ashbourne. Mr. John Shaw, jun., of Derby, with the assistance of Messrs. Dickinson, of Birmingham, well known in connection with the South Staffordshire Electric Railway, has prepared a scheme for the construction of this light railway, and the proposal has already met with much favour, alike from the landowners, farmers, and others in the district. The prime cost of the railway equipped in the ordinary way was estimated at from £30,000 to £50,000 per mile. Consequently, such a railway running from Derby to Ashbourne would cost from £600,000 to £800,000, whereas to build and work a light electric railway on the overhead electric system has been amply proved to be the cheapest and most suitable method in the case of the Derby and Ashbourne line. The cost of running per car mile by the overhead system, including all expenses, with the exception of guards' wages and maintenance of permanent way, is estimated at 4·06d., compared with 8·57d. by steam. It is proposed that the line should be connected with the existing Derby tramway, which terminates on the Ashbourne-road, and thence it would run through the parishes of Mackworth, Kirk Langley, Brailsford, Ednaston, Osmaston, Compton, into the town of Ashbourne, terminating near Compton Bridge.

Electrocution of Shade Trees.—It is a question, says the *Chicago Record*, whether the stringing of electric wires in cities and villages will not destroy a large proportion of the shade trees. Complaint is made in several cities that where the wires pass through the foliage the trees in nearly every instance have died, presumably from the effects of the electric current. It has been noticed also that the death of the trees almost invariably follows a season of rain, when the wet leaves are good conductors of electricity and carry it from the wires to the trees. In some cases the death of trees has been caused by wires supposed to be thoroughly insulated, the covering having been rubbed off the wires by the friction of the branches when moved by the wind. The evidence that the trees have been killed by electricity is furnished by the fact that in numberless instances the trees through which the wires pass died in an hour during a storm, while those standing a few feet from the wires were uninjured. These results will raise the question as to the liability of electric light companies for the damage caused by the killing of shade trees. The right to string electric wires does not give the further right to destroy the shade trees, which may constitute the chief value of a piece of real estate. Neither does it give the right to lop off the branches and otherwise disfigure ornamental trees simply because such branches happen to be in the way of the wires. This has been done by an electric light company in one of our suburban villages, and many large and beautiful trees have been practically ruined by such vandalism.

British Association Ipswich Meeting. — The following is the probable programme of Section G.: Thursday, 12th—Address by President, Prof. Vernon Harcourt, M.I.C.E.; Light Railways in Agricultural Districts, Major-General Webber; Congelation of Soil for Foundation Purposes, M. Gobert (a Belgian engineer); Bentley Coal Borings (a local work), R. C. Rapier. Friday, 13th—The Growth of the Port of Harwich, W. Birt (general manager, Great Eastern Railway); Notes on Improvement of Mass in Connection with Hook of Holland Route, the President; Snowdon Tramroad, Sir Douglas Fox; Notes on Autumn Floods of 1894, W. H. Symons; River Weirs and Flood Prevention, F. G. M. Stoney (designer of Richmond Weir). Saturday, 14th—Dredging Operations at Mersey Bar, A. G. Lyster, M.I.C.E.; Carbonic Anhydride Refrigerating Machinery, E. Hesketh (of Hall and Co., Dartford); Deodorising Sewage by Hermite Process at Ipswich, F. Napier (borough analyst). Monday, 16th, electrical day—Induction Telegraphy, Notes on Further Advance, W. H. Preece; Glow Lamps, W. H. Preece; Modern Applications of Electricity to Traction, P. Dawson; The Chloride Battery, W. H. Earle; Extension and Development of the Telephone in Agricultural Districts, Major-General Webber; Telephony, A. R. Bennett; The Field Telegraph in the Chitral Campaign, P. V. Luke (Deputy Director of Telegraphs in India); A New Portable Photometer, W. H. Power and A. E. Trotter. Tuesday, 17th—Interim Report of Committee on Standardising; Modern Flour-Milling Machinery, F. W. Turner; Paper-making Machinery, Mr. Mason; Printing without use of Movable Types, J. Southward; Incandescent Gas Lamps, C. Cooke; B.A. Standard Small Screws, R. B. Crompton; Uniform Factor of Safety in Steam-boilers, J. Key.

Fatality.—"A shocking accident, which resulted in the death of a young man, named Waller, aged 23, a native of Blackburn, Lancashire, occurred on Monday on the electric tramway at Bushmills. It appears that he and another young man were coming from Belfast around the coast to Portrush on bicycles, and when about a few hundred yards beyond the tramway station on the Portrush road, it is believed that the deceased, endeavouring to run his bicycle on to the tram line, struck the elevated kerbing of granite, about 5in. in height, which at this place divides the county road from the tram line, and was pitched over the machine on to the elevated rail, which was then charged with electricity. His companion, who was a few yards in advance, hearing the deceased shout, returned to his assistance, and found him lying on the rail and his bicycle on the top of him, and also in connection with the rails, thus probably causing a double current of electricity to pass through the body of the deceased. In trying to release the body from the rails the deceased's companion had a severe shock, owing to the ground rail and clothing of the deceased being wet. The unfortunate young man was immediately removed to the waiting-room at the station, where, despite the efforts of two doctors, he expired shortly afterwards." We have taken the report of this sad accident from the account given by the *Daily Telegraph*. It is exceedingly difficult to understand how such a fatal accident could have happened. Having passed over the line on Saturday and Sunday last, we have the details of construction fairly in mind. The rails form the return circuit and the current is taken from a rail about 18in. above the ground. The voltage does not usually, we were informed, exceed 300 volts, so that one could hardly have expected such an accident.

Epoch-Making Inventions. — An American subscriber, at present in Paris, writes to us that he is pained to see that we have located the good Ananias as an inhabitant of the great American Republic. He, as evidence of the good faith of American journalists, sends us an item from the *New York Mail*, observing that as this is an age of unbelievers there will very likely be found some readers who will question its accuracy, but at the same time it is entertaining. The paragraph runs: "Dr. Denkla M. Squilmuth, ex-supervisor of the poorhouse at Malvern, L.I., has at his farm, near Dendy's Station, a remarkable herd of shorthorn Jerseys. For three summers past he has lost several by lightning, and this year four were killed during June. He now has each

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cow fitted out with a small lightning rod and a storage battery, and, while none has been killed, so great is the amount of electricity secured that the batteries provide all the power needed to run the doctor's six big churns, the daily product of which is over one thousand pounds of butter." But, after all, Glasgow is turning up as an opponent of the States. Some newspaper man there has wired to various papers (and had accepted) the following astounding information: "Two Glasgow gentlemen have just taken out provisional patents for an invention which, it is claimed, will mark an epoch in the mining history of the world, and more particularly Western Australia. The invention is pneumatic in character, and will do away with water power for working the stamps, substituting a combination of electricity and air. The Western Australian Government are interested in the invention, and the Rothschilds are understood to be desirous of launching the company, provided they get certain controlling powers. The capital will be the largest of any company this century."

Regulation of Dynamos Driven by Fixed Expansion Steam-Engines.—M. F. Mélotte recently made a communication to the Association des Ingénieurs-Electriciens de Montefiore in which he stated that he had found that in order to increase the voltage of a shunt dynamo driven by a fixed expansion engine it is in certain cases necessary not to augment, but to diminish the excitation. Take the instance, he says, of a steam-engine the governor of which acts only on the valve. It is ascertained, for example, that at a little below full load the engine does not attain its normal speed, and that the voltage as well as the output of the dynamo are very small. The steam entering, the energy per piston-stroke is maximum, and the power furnished by the engine is proportional to the speed. If, with the object of increasing the voltage, the excitation be augmented, this is what follows: the load of the steam-engine increases; the engine slackens, but the power of the dynamo diminishes more rapidly than the speed, while that of the steam-engine decreases proportionally to this speed; so that a state of equilibrium is attained at a speed lower than the primary speed. At the same time the voltage has naturally declined, so that in increasing the excitation you have run counter to the desired object. If, on the other hand, the excitation be diminished, the load inclines to decrease, and the engine gains in speed and yields a proportionately greater power; but with the speed the load of the dynamo augments more rapidly than that of the motor, whence a new state of equilibrium at higher speed and voltage. This method of regulation ceases to be efficacious when, the proper speed being obtained, the governor begins to act; then a fresh diminution of the excitation would cause a decrease of the magnetic field which would no longer be compensated by an increase of speed, and the voltage would diminish. In a case quoted by the author, with an engine of 300 h.p., at 350 revolutions a minute, which, with full excitation, only made 315 revolutions and supplied 115 volts, the speed has been caused to rise to 350 revolutions and the voltage to 125 with full load by diminishing the excitation. M. Mélotte has observed the same incident of regulation in the driving of a dynamo by a gas-engine.

Then and Now.—The late Sir William Siemens in 1877, in an address before the Iron and Steel Institute, said: "The advantage of utilising water power applies, however, chiefly to continental countries, with large elevated plateaus, such as Sweden and the United States of America, and it is interesting to contemplate the magnitude of power which is now for the most part lost, but which may be, sooner or later, called into requisition. Take the Falls of Niagara as a familiar example. The amount of water passing over this fall has been estimated at 100,000,000 tons per hour, and its perpendicular descent may be taken at 150ft., without counting the rapids, which represent a further fall of 100ft., making a total of 300ft. between lake and lake. But the force represented by the principal fall alone amounts to 6,800,000 h.p., an amount which, if it had to be produced by steam, would necessitate an expenditure of not less than millions of tons of coal per day. It would not be very difficult, indeed, to realise a large portion of the power so wasted by means of turbines and waterwheels erected on the shores of the deep river below the falls, supplying them from races out along the edges. But it would be impossible to utilise the power on the spot, the district being devoid of mineral wealth or other natural inducements for the establishment of factories. In order to render available the force of falling water at this and hundreds of other places similarly situated, we must devise a practical means of transporting the power. As regards electrical transmission, suppose water power be employed to give motion to a dynamo-electric machine, a very powerful electrical current will be the result, which may be carried to a great distance through a large metallic conductor, and then be made to impart motion to electro-magnetic engines, to ignite the carbon points of electric lamps or to effect the separation of metals from their combinations. A copper rod 3in. in diameter would be capable of transmitting 1,000 h.p. a distance of, say, 30 miles—an amount sufficient to supply 250,000 c.p., which would suffice to illuminate a moderately sized town." What he then talked of as being merely within the range of possibilities is to-day an accomplished fact. It is on record that his audience received the statements made with an incredulous smile.

A Cable for St. Helena.—St. Helena is one of our possessions with which we have no telegraphic communication. The subject is dealt with by a writer in the *St. Helena Guardian*, who says: "Some years ago Mr. Haliburton wrote about the defenceless state of St. Helena, and in his most able letter he points out the want of a cable from the Imperial side of the question. In this matter Imperial and island interests are one. Without a cable St. Helena, and I might add Ascension, are worse than valueless to the Empire, seeing that these would be, in war time, a constant source of anxiety, the Home authorities not knowing whether these islands were captured, besieged, or what not. With a cable the island could be used as a base for cruisers to operate from with a view of protecting the Cape route to the East, and a large stock of coal would no doubt be kept for cruisers making the island their headquarters. This much for the Imperial advantages of having the wire laid down. From the islanders' point of view, I do not hesitate to say that a cable would benefit every man, woman, and child in the place, and more than double the value of property in St. Helena. Of the scores of ships which now pass without calling at least two-thirds would call for orders; there is no better situated place anywhere than St. Helena for getting orders at for sailing vessels. I have little doubt that the regular mail steamers to the Cape would also stay here for a brief period if once the cable was established to communicate with England and the Cape. Men-of-war would, instead of remaining a few days, and having to run up to Sierra Leone if they wished to communicate with the admiral, stop here for weeks and perhaps months at a stretch, provided the Nanas and Kokos on the coast were quiet. I need not dwell on the advantages of men-of-war

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being in port; they are apparent to all. The many schemes for resuscitating St. Helena I think all hinge on the cable; freights would fall owing to more ships visiting the place, at present they are sufficiently high to kill any export trade that might be started. Finally, from a speculator's point of view, I feel sure the St. Helena cable would pay the investor. Ships would use it to inform their owners of their arrival and to get orders where they were to go to discharge. The Colonial Office would use it to send instructions from time to time to the Governor, the War Office would use it in connection with the garrison, the Admiral and the Admiralty would use it for the men-of-war and troopships calling here. Private individuals and business men would use it, and the steamship companies would, with the passengers, wire home reporting their arrival and departures."

Professional Ethics.—The following code of ethics has been adopted by the Boston Society of Architects as a guide to its members. Although some of the statements show somewhat of the trade union spirit, we should be pleased to know that all our consulting engineers were prepared to abide by the spirit of this code in future. The code reads as follows: No member should enter into partnership, in any form or degree, with any builder, contractor, or manufacturer. A member having any ownership in any building material, device, or invention proposed to be used on work for which he is architect, should inform his employer of the fact of such ownership. No member should be a party to a building contract except as "owner." No member should guarantee an estimate or contract by personal bond. It is unprofessional to offer drawings or other services on approval and without adequate pecuniary compensation. It is unprofessional to advertise in any other way than by a notice giving name, address, profession, and office hours, and special branch (if such) of practice. It is unprofessional to make alterations of a building designed by another architect, within 10 years of its completion, without ascertaining that the owner refuses to employ the original designer, or, in event of the property having changed hands, without due notice to the said designer. It is unprofessional to attempt to supplant an architect after definite steps have been taken toward his employment. It is unprofessional for a member to criticise in the public prints the professional conduct or work of another architect except over his own name or under the authority of a professional journal. It is unprofessional to furnish designs in competition for private work or for public work, unless for proper compensation, and unless a competent professional adviser is employed to draw up the "conditions" and assist in the award. No member should submit drawings except as an original contributor in any duly instituted competition, or attempt to secure any work for which such a competition remains undecided. The A.I.A. "schedule of charges" represents minimum rates for full, faithful, and competent service. It is the duty of every architect to charge higher rates whenever the demand for his services will justify the increase, rather than to accept work to which he cannot give proper personal attention. No member shall compete in amount of commission or offer to work for less than another, in order to secure the work. It is unprofessional to enter into competition with or to consult with an architect who has been dishonourably expelled from the "institute" or "society." The assumption of the title of "architect" should be held to mean that the bearer has the professional knowledge and natural ability needed for the proper invention, illustration, and supervision of all building operations which he may undertake. A member should so conduct his practice as to forward the cause of professional education and render all possible help to juniors, draughtsmen, and students.

Institution of Junior Engineers.—The Belgian summer meeting of this institution, which took place last week, passed off very successfully. Assembling at Harwich, the party, consisting of nearly 60 members, crossed by the Great Eastern Railway's ss. "Ipswich," and arrived at Antwerp on Saturday morning, the 17th inst. Here they were welcomed by M. Royers, engineer-in-chief to the Municipality, who conducted them over the extensive docks, and explained the numerous features of interest in connection therewith. The Musée Plantin and the station of the Compagnie Hydro-Electrique Anversoise were also specially open for inspection. On Monday the members proceeded to Ghent, where MM. Carel's engine works, M. Van Houtte's nursery gardens, and M. de Hemptinne's cotton-spinning mills were seen, the respective proprietors showing the visitors round. In the evening Brussels was reached, and the central electric light station there was visited under the guidance of Mr. Phibbs. Tuesday was left open so as to afford the opportunity of visiting the various places of popular interest for which the city of Brussels is noted; in the afternoon, most of the party made an excursion to the field of Waterloo. Leaving Brussels on Wednesday morning, the members arrived at Liège about noon, and were received by M. Gillon, president of the Association of Engineers from the University of Liège, and by M. Firkets, president of the Liège section. The afternoon was devoted to visits to the Vieille Montagne Zincworks at Angleur, under the direction of M. Gillard, secretary of the company, and other gentlemen; and the St. Leonard Locomotive Works, where the chief engineer, M. Shoest, showed the members over. In the evening, at the Hôtel de Suède, a banquet was given in honour of the institution by the Liège section of the Association of Engineers from the University, M. Gillon presiding, faced by M. Firkets. On Thursday an excursion was made to Verviers, on the invitation of the Chamber of Commerce. Arriving at Est Station, the president, M. Garot, M. Mullendorff, M. Soubre (secretary), and other gentlemen of the town, met the members, and entering carriages drove to the wool-washing, combing, and dyeing works of MM. Peltzer et Fils. The wool-card manufactory of M. Duesberg-Debrez was next visited, after which the party were entertained at luncheon at the Société de l'Harmonie, M. Garot presiding. The wool-spinning, weaving, and finishing works of MM. Peltzer were seen afterwards, and train was then taken for visiting, under the guidance of the engineer, M. Mahwood, the Gileppe reservoir, which supplies water to Verviers and Liège. In the evening the Liège electric lighting station was seen, Mr. Hickson conducting the members through it. Friday's programme comprised a visit to the extensive works of the celebrated Cockerill Company, where the party were welcomed by M. Delloye Matthieu, chairman, and M. Kraft, chief engineer to the society. Luncheon was subsequently served, and in the afternoon the Val St. Lambert Glass Works were visited, with M. Deprez, general manager, as guide. In the evening the summer dinner of the institution was held in the Salle des Vitraux of the Hotel Mohren, Liège, the chairman (Mr. H. J. Young) presiding. On Saturday, sectional visits were paid to the Small-Arms Works, the Liège electric tramway installation, the works of the Compagnie Internationale d'Electricité, the Liège Gasworks, and M. Fouldu's Iron Foundry. The party returned to England in the afternoon. At each place visited throughout the week, the Belgians were exceedingly cordial and generous in their welcome, evoking from their visitors expressions of the heartiest appreciation.

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THE ANNUAL MEETING OF THE VERBAND DEUTSCHER ELEKTROTECHNIKER AT MUNICH.

(BY OUR SPECIAL CORRESPONDENT.)

(Concluded from page 212.)

INTERVIEW WITH MR. EMIL KOLBEN.

Armed with an introduction from Mr. F. Drexler, the representative of the Oerlikon Works in Vienna, whom I had met at the Munich meeting, I made my way to Oerlikon. After some difficulty I succeeded in finding Mr. Kolben, who very kindly conducted me to his private office. We first compared notes as to our previous interview in London, when Mr. Kolben was there in 1892; and then I proceeded to put him on the rack.

"What is the usual system of town-lighting in Switzerland, Mr. Kolben?" I asked.

"In all towns," he replied, "where electric lighting is the chief *raison d'être* of the supply we use single-phase alternating currents, and in this system employ motors up to 10 h.p. or 12 h.p. In no case is direct current now being installed for large towns, as the cost of the mains is considered with us to be a prohibitive item. In some small

Emil Kolben.

villages, where the lighting is very compact and close to the source of power, we continue to use direct-current machines for lighting and power."

"What voltage do you usually employ?"

"We standardise our alternators and transformers in the following pressures: 1,000, 2,000, 3,000, and 5,000 volts. These pressures are generated directly in the alternators, and there are no transformers employed at the primary station, but for pressures over 5,000 we transform up. In fact, the Oerlikon Works are driven from a water-power installation 16 English miles away, and in this instance a pressure of 13,000 volts is used, with transformers at each end."

"In the town-lighting schemes designed by you, what cables do you employ?"

"The Swiss and German practice is to use lead-covered paper cables exclusively. These are laid usually in a stoneware conduit or trough, and in a few cases in cast-iron conduits. In other places the earthenware conduits are replaced by iron armouring on the cable."

"Now, as regards the works cost, Mr. Kolben. Do you consider that you are able to produce and sell electricity cheaper than we can in Great Britain?"

"We have no compulsory returns of the cost per unit, as you have in England, in the various electrical stations with which I have had to do. I cannot give the details so fully as you would like. I may, however, say that in Zürich, where the charge is 70 centimes (6¾d.) per kilowatt-hour, the authorities make a considerable annual profit out of the undertaking."

"Is not water power used at Zürich?" I queried, "and what does it cost?"

"For small units," was the answer, "the average charge about Zürich for water power varies from 200f. to 300f. (£8 to £12) per horse-power per annum, but if the company builds its own waterworks it often succeeds in reducing this figure."

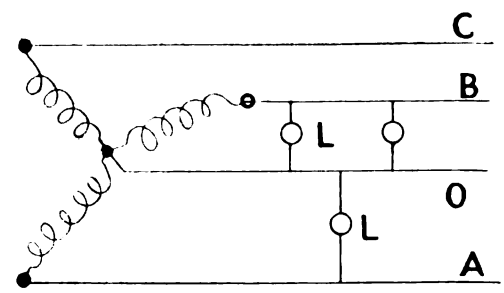

FIG. 1.—Three-Phase System with Zero Wire for Lighting.

"Apart from town-lighting schemes, what system would you adopt for transmission of power?"

"I use the three-phase alternating system for large transmission work if the main demand is for power, as with this the cost of the line is a minimum. If lighting is required on the same system, we sometimes use the star winding and run a neutral wire from a common junction. I then place the lamps between any one of the three wires and the neutral wire, and in this way the fluctuation of voltage when the branches are unequally loaded is to a large extent prevented" (Fig. 1).

"When you are starting single-phase motors, on lighting the circuits don't you find that they cause objectionable variations of voltage on account of the large starting currents they take?"

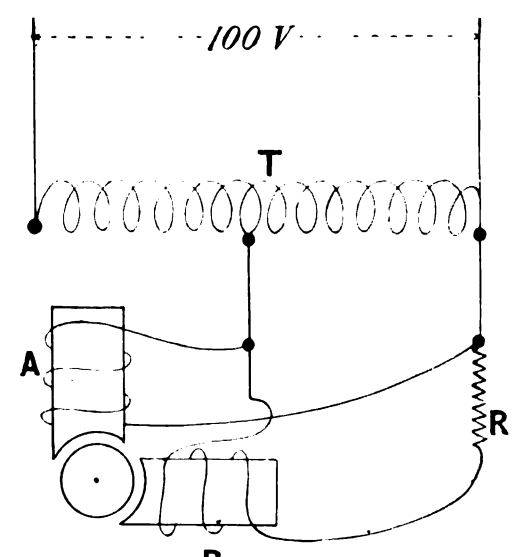

FIG. 2.—Diagram of Starting Connections for Oerlikon Single-Phase Motor.

"The method which I have devised and standardised for use with our motors is, roughly, as follows: Instead of using the full voltage when starting the motors, I employ a transformer in connection with the switch, so that the energy required to start a motor is attained at a low voltage by transformation (Fig. 2). In this way the actual current taken from the main in starting is always less than the normal working current of the motor, and with moderate-sized motors is often less than half. We also supply our motors with a fast and loose pulley arrangement, so that they are started free, or without load, and the frictional clutch introduces the load gradually if the motor has attained its speed" (Fig. 3).

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"What do you consider the most interesting scheme of power and light distribution by electricity with which you have had to do lately?"

"We have erected at La Goule, in the West of Switzerland, single-phase electric lighting works of 1,500 h.p. From this point we supply a district having extreme points 16 English miles apart. The industry of the district consists of watch manufactories, and about a dozen small towns and villages are supplied with light and power. The charges for power are approximately as follow: 320f. (£13) per annum for a ¼-h.p. motor; 125f. (£5) per horse-power per annum for motors varying in output from 2 h.p. to 12 h.p. Overhead wires are used in this installation at a pressure of 5,000 volts."

guarantee for our standard frequency of 50 complete cycles per second should hold good even at such abnormal frequencies as 133 per second."

In walking through the works, the first machines which attracted my attention were some direct-current dynamos designed for the Aluminium Company of Scotland. Five of these machines are required, the output of each to be as follows: 8,000 amperes at 65 volts for running at a speed of 150 revolutions per minute. Mr. Kolben has designed these machines with 24 poles, the armatures being drum wound. One hundred and twenty brushes are used to collect this enormous current, and the weight of iron in the field magnets is about 17 tons. I was privileged to see the armatures of these machines in

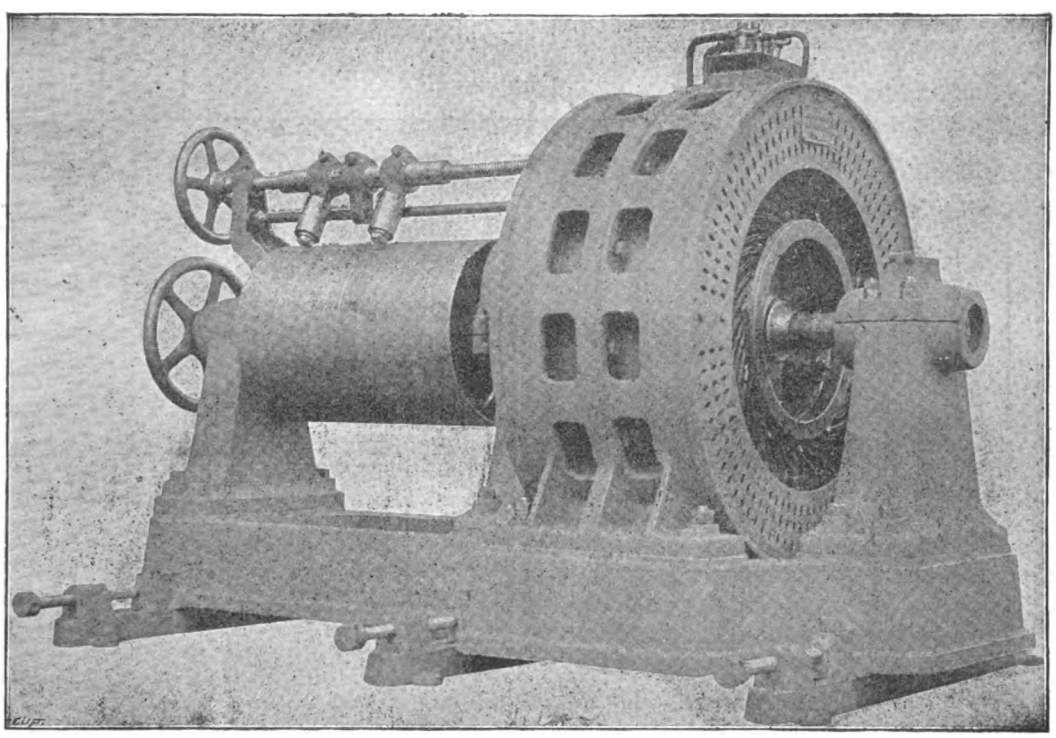

FIG. 3.—Oerlikon Single-Phase Motor, showing Fast and Loose Pulley

Mr. Kolben, after answering my questions, proceeded to put me through the same ordeal, and he manifested great interest in the various items of English news which I was able to give him. He then asked me to accompany him round the works, in order that I might see some of his designs in course of construction; but before starting I asked him what he thought of the prospects of electric motors on alternating-current circuits in England. He replied:

"I have found the greatest difficulty in answering the numerous enquiries that I receive from England for motors

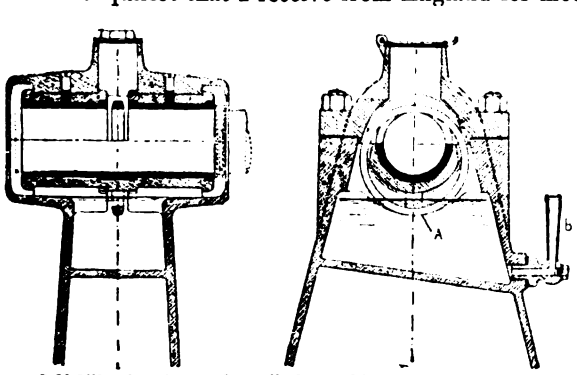

FIG. 4.—Self-Oiling Bearing used on all the Oerlikon Dynamos and Alternators.

on account of the great variations in frequency. It appears to me that you have in England frequencies of so wide a range as to render the standardising of electric motors almost impossible. Almost every enquiry that I get from your country requires either a new design or some large alteration of our existing types to ensure a reasonably efficient motor; and the idea seems prevalent that the figures we

various stages of construction, and was struck with the neatness of the design. Stranded conductors are employed, and to prevent the conductors flying outwards under centri-

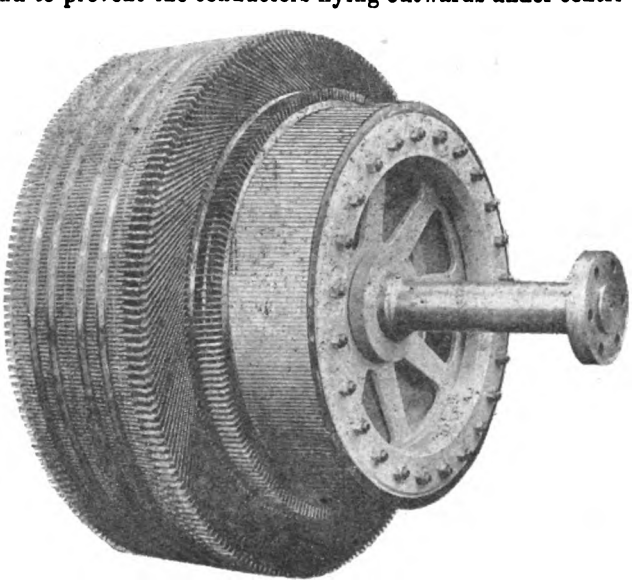

FIG. 5.—Armature of a Large Multipolar Oerlikon Dynamo.

fugal force they are threaded through holes in brass plates, which are bolted into the core. The diameter of the armature being 7ft. 3in., the circumferential speed of the conductors is 3,420ft. per minute. The ordinary binding-wire arrangement would not be a sufficient safeguard at this speed and diameter.

The whole of the machinery in the works is driven by

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alternate-current motors. The power is derived from a water-power plant situated 25 kilometres away. The pressure employed is 13,000 volts, which is transformed down to 190 volts at the works for distribution to the various motors. Each motor usually drives a section of the line of shafting, but the larger machine tools have separate motors attached. The various details of construction in the dynamos and alternators turned out by the Oerlikon Company show that great care has been bestowed upon them. The ring method of obtaining constant lubrication has been universally adopted by this firm. Fig. 4 shows two sections of their standard bearing.

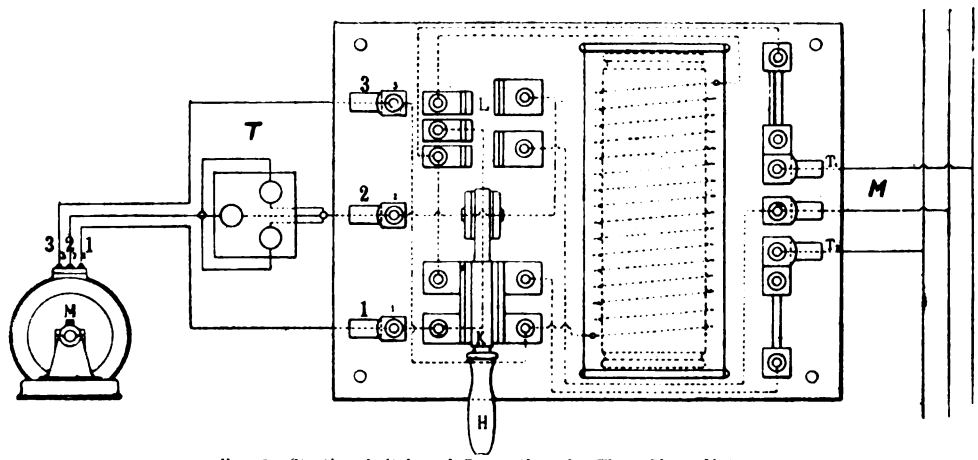

FIG. 6.—Starting Switch and Connections for Three-Phase Motors.

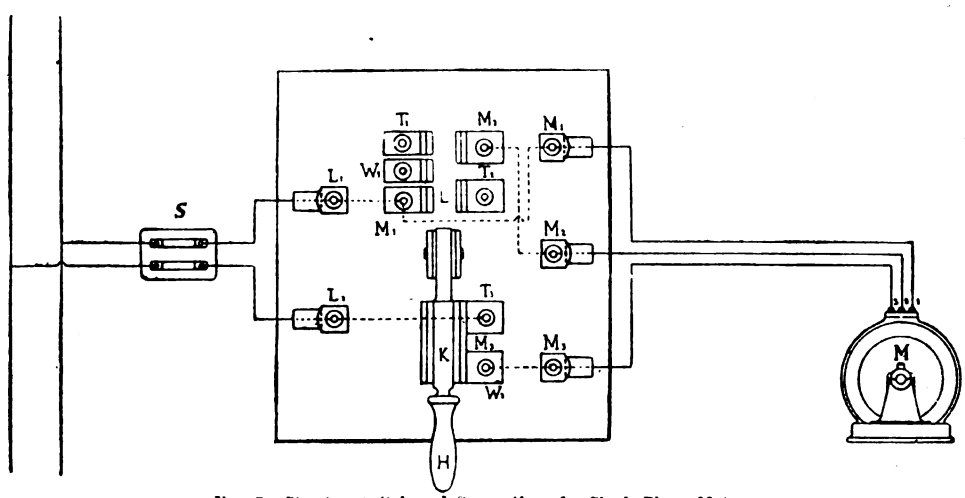

FIG. 7.—Starting Switch and Connections for Single-Phase Motors.

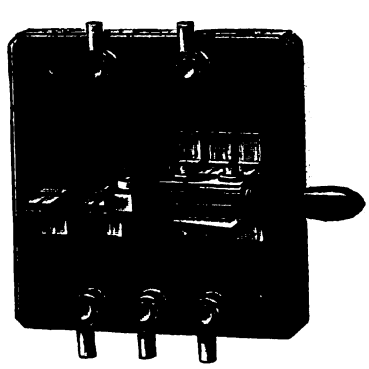

FIG. 8.—Starting Switch.

The following *résumé* is extracted from the instructions issued with the Oerlikon alternator-current motors, and will give a good idea of the connections used. Fig. 6 refers to motors on three-phase circuits, and Fig. 7 to single-phase alternate-current motors, Fig. 8 being a perspective view of the same. Steady foundations should be provided for the motor, which may preferably be mounted on wood to ensure good insulation from earth. The starting switch should be placed handy, and the connections made to it as shown in diagram. In starting, the belt must stand on the loose pulley, R_1 (Fig. 9), which must not be touching the fixed pulley, R. When the motor is not in use, the handle, H, of the switch (Figs. 6 and 7) is vertical, and does not make contact with either K or L. All being ready, the handle is moved over into the K position which gives an arrangement of connection similar to those described above by M. Kolben in this interview. The motor then starts and quickly reaches its normal speed. The note or hum given out tells the operator when this speed is attained.

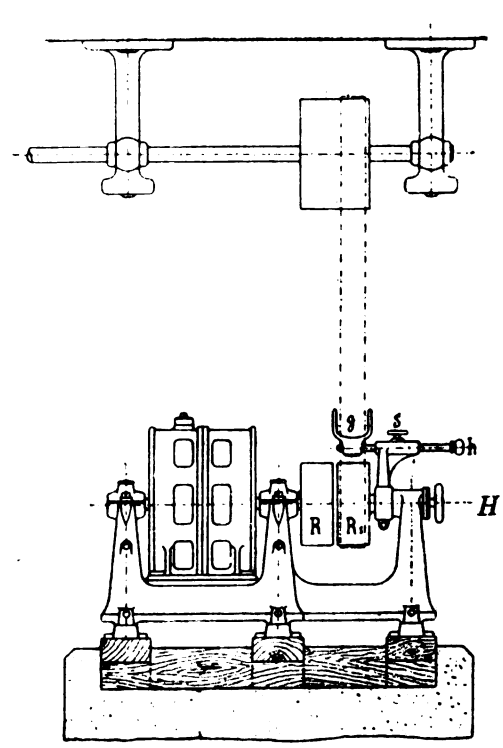

FIG. 9.—Fast and Loose Pulley Arrangement.

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and the handle, H, should then be changed over into the L position as quickly as possible. The motor is then ready to be put on its work. This is done gradually by means of the fast and loose pulley gear. The hand-wheel, H, when screwed in causes the loose pulley, R_1, with the belt on it, to be driven by friction. The belt then can be slowly moved over on to the fast pulley, R, by means of the striking gear, *g* and *h*, which is clamped by the set screw, *s*. Both motions being gradually per-

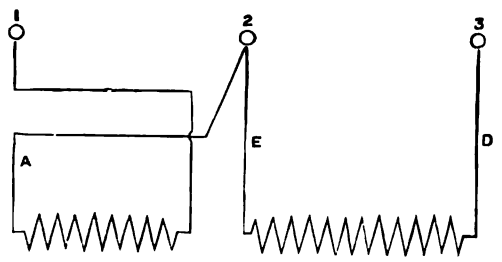


FIG. 10.

formed, the motor will never take an excessive current, or cause any fluctuation in the lights supplied off the same mains.

Should the direction of the motor need to be reversed for any reason, the connection of one winding only need be changed, Fig. 10. Care must be taken that the switch is never thrown first into the L position, and that after stopping, the loose pulley, R_1, is always left out of contact with the fast pulley.

PROF. THOMAS'S INCANDESCENT LAMP TESTS.

Prof. Benjamin F. Thomas, of the Ohio State University, Columbus, Ohio, has recently completed an elaborate series of tests on the "Packard" incandescent lamp, made by the New York and Ohio Company, of Warren, O. The report of the test is lengthy, and the following is a brief abstract of it:

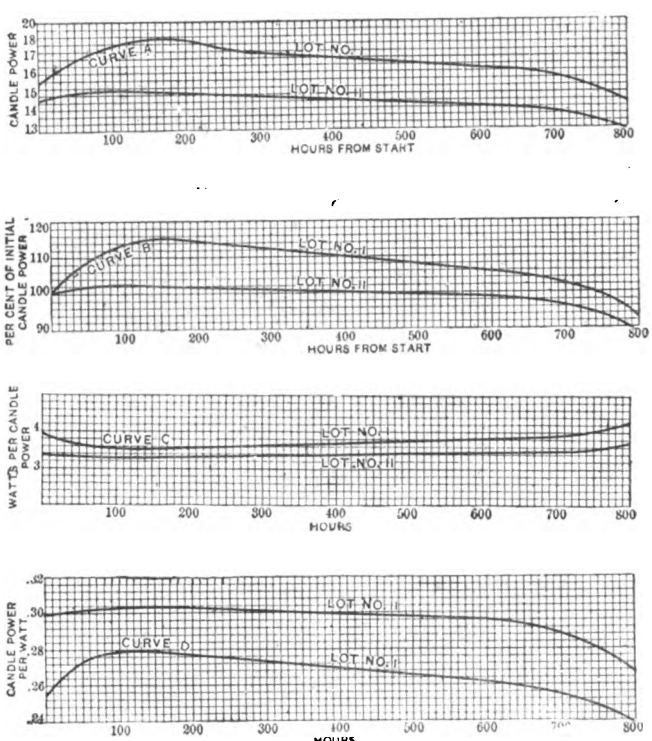
The tests were very carefully conducted, Weston measuring instruments and a Summer-Brodhun sighting-box adapted to an accurately-graduated portable photometer bar 100in. long being used. The results of the tests, showing the average of Lot No. 1, are given in the following table:

Hours from start of test.	Number of lamps burning	Candle-power.	Per cent. of initial candle-power.	Watts per lamp.	Watts per candle-power.	Candle-power per watt.
0	25	15·54	100	61·00	3·93	·254
96	25	17·58	113·2	63·12	3·59	·279
144	25	17·84	115·0	63 62	3·57	·280
192	25	17·82	115·0	63 54	3·57	·280
252	25	17·53	113·0	63 55	3 63	·275
312	25	17·30	111 4	63 41	3·66	·273
360	24	17·04	110 0	63·30	3 70	·270
408	24	17·08	110 0	63·30	3 70	·270
480	24	16·68	107·5	63 00	3 88	·265
528	24	16 70	107·5	62 73	3 76	·266
600	24	16·35	105·3	62 64	3·83	·261
648	23	16·07	103·4	62·60	3 90	·256
696	22	15 83	102·0	62·60	3 95	·253
768	22	14 81	95 3	61·94	4·17	·240
812	22	14·50	93·3	61·51	4·24	·236

The electric readings were taken by two experienced students, Messrs. A. H. Jones and R. D. McCarter, jun. One hundred lamps, labelled "16 c.p., 100 volts," were obtained for this test. They were about equally divided in two lots, having distinguishing marks inside the bulbs. Twenty-five lamps were taken at random from each lot for test.

The voltage was not perfectly constant, and no attempt was made to secure unusual constancy, for the reason that the circuit arrangement used enabled us to work the lamps under the conditions ordinarily existing in central-station practice. The results may therefore be considered as a better indication of what lamp users may reasonably expect from similar lamps, than if the lamps had been run at an unvarying voltage. From readings taken on different days and at different times of day, I think the average voltage was about 99.

The values of Tables I. and II. (the first is the only one given here) are plotted in terms of candle-power and time in Curve A, of percentage of initial candle-power and time in Curve B, and of efficiency and time in Curve C. As shown by these curves, Lot I. shows a marked increase in candle-power on the start, reaching a maximum of 17·9 candles at about 175 hours, then decreases uniformly until 600 hours, when a more rapid decrease sets in. The candle-power does not fall to its initial value of 15·54 candles until over 700 hours from the start. Lot II. shows only a moderate rise in candle-power with a maximum at about 150 hours, and then decreases uniformly to its initial value at 400 hours. It shows also a sharp increase in declining brightness at 600 hours. This change may have been produced by strain due to abnormally high voltage at soon after the 600-hour point. Such a high voltage was observed for some time during the day preceding the evening on which the readings at 696 hours were taken. Curve C shows a marked increase in efficiency for Lot I. on



the start, falling back to the initial value only after 600 hours. Lot II. improves in efficiency also at the start, though to a smaller extent, and continues at a practically uniform figure for 600 hours. The decrease in efficiency for each lot after 600 hours is much less rapid than usually met with.

It will be noticed that the breakage is remarkably small. No lamp of either lot showed any serious blackening, and the majority of the lamps were scarcely blackened at all.

The report ends by saying that, taking economy, maintenance of candle-power, and freedom from blackening into account, the results obtained are much superior to any heretofore published.

TEST OF TWO CASTLE MOTORS.

Last week a most interesting test of two 150-h.p. "Castle" motors was conducted at the works of Messrs. J. H. Holmes and Co., at Newcastle-on-Tyne. These motors, which are to be exported to a firm in South America, have been built to a most rigid specification.

The motors were drum-wound, the armatures being constructed after the methods standardised by this firm. The connectors are so designed that the connection to the brushes are made at the centre of each connector, this method giving horizontal position to the brushes. The motors before being accepted had to be run continuously

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for 24 hours at full load, and to have a commercial efficiency of 92 per cent., together with a low temperature rise in both armature and magnets.

As a full-load run of this duration is both expensive and difficult to arrange where the power is absorbed on a brake, Mr. J. H. Holmes determined to test the two motors by the Kapp method. In this way the actual power to be supplied is limited to that corresponding to the electrical and mechanical losses in the two machines at full load. The arrangements of test were as follows: The two motors were bolted on to a combined frame, Fig. 1, and geared together by a guttapercha belt, the torsion in which could be adjusted by moving one of the machines on its rails in the usual manner. The armatures were then connected in series, as shown diagrammatically in Fig. 2.

In the circuit a small generator was also connected to supply the necessary power. This series method was adopted because a suitable dynamo giving 600 amperes was available, and there was little difficulty in driving it at the low speed in order to obtain about 35 volts. The series method also has the advantage over the method by which the power is supplied at the normal voltage, that the readings for determining the efficiency are obtained from a voltmeter instead of from ammeters. One voltmeter with a two-way switch, with the connections as shown, gives the two readings necessary. The field of the two machines were each connected in shunt across the brushes of their respective armatures. Regulating rheostats, R R_1, were inserted, and enabled the field to be varied to get the corrected current, speed, etc. During the trial the current in the main circuit was read on a Weston milli-voltmeter, A, measuring fall of potential at the ends of a standard resistance in the circuit. The voltmeter, V, was also a Weston instrument.

In starting up, the field of the machine, M, which was to act as the motor in the combination, was strengthened, and that of the dynamo, D, weakened. The loss in the conversion of power is then supplied by the auxiliary dynamo, X, which was separately excited. After the adjustment of the rheostats to get the correct speed, current, and voltage had been made, the eight following readings for the efficiency test were obtained:

Motor.			Generator.			Time.
Volts.	Amperes.	Revs.	Volts.	Amperes.	Revs.	
216	600	522	182	600	514	9.30 a.m.
212	539	499	179	530	492	11 ,,
216	590	500	183	590	495	11·30 ,,
214	600	506	181	600	501	11·45 ,,
215	600	508	182	600	503	12 ,,
215·5	604	510	182·5	604	503	12.15 p.m.
216·5	615	512	183 5	615	503	12.45 ,,
213	600	534	180	600	522	1.15 ,,

The mean of these first readings gave the voltage on the motor as 215 volts, as compared with 184 volts on the dynamo. If the two machines were rigidly geared, these figures would give the efficiency direct, but in this case the mean speed of the motor was 511 revolutions per minute, and that of the generator 504·1 revolutions per minute. This shows a belt-slip of 1·42 per cent., as the pulleys were of the same diameter. Hence a correction must be applied to the volts obtained from the generator, as without the belt-slip the speed of it would be 1·42 per cent. higher, and the voltage would be increased by an amount depending on the efficiency of the dynamo. Assume this to be 92 per cent., the correction in the voltage will be

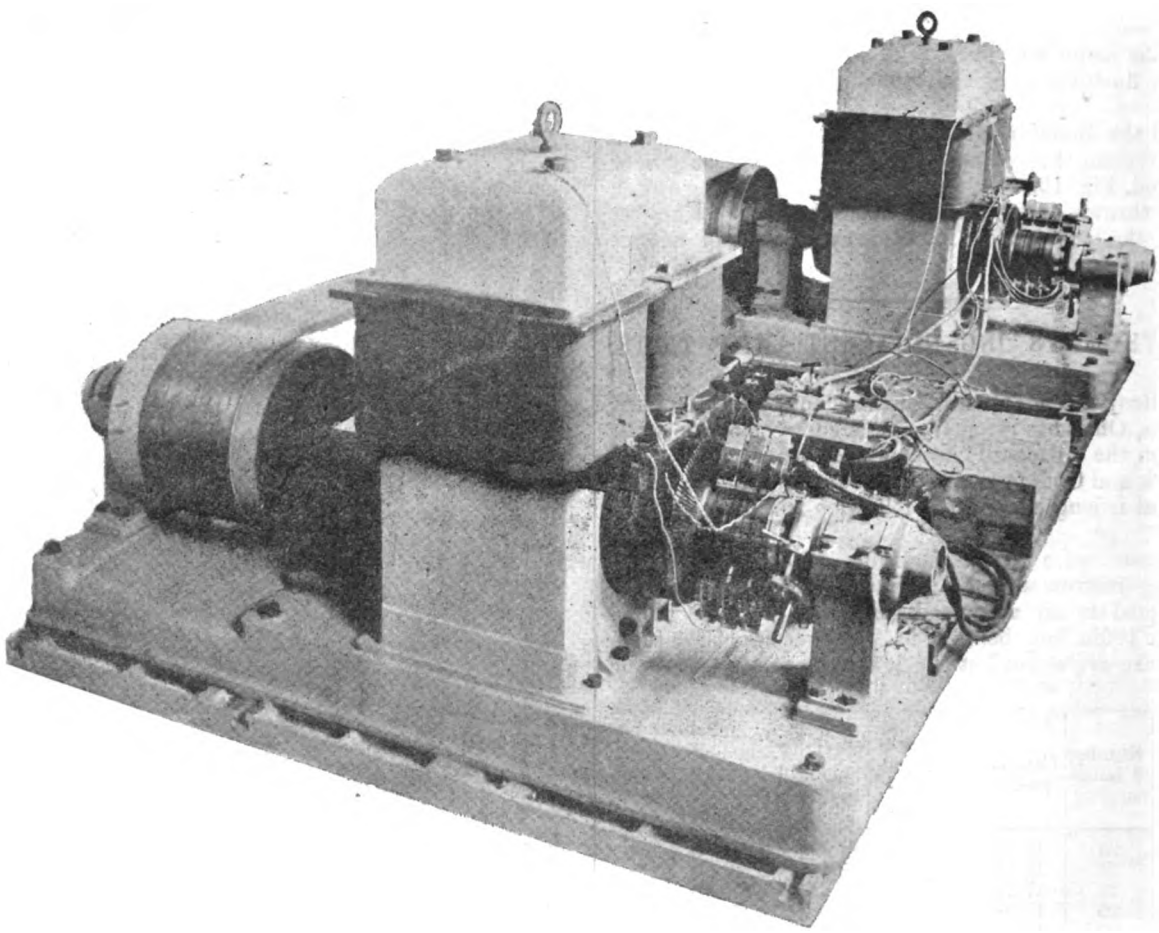

FIG. 1.—View showing the Two Castle Motors as Mounted for Efficiency Test.

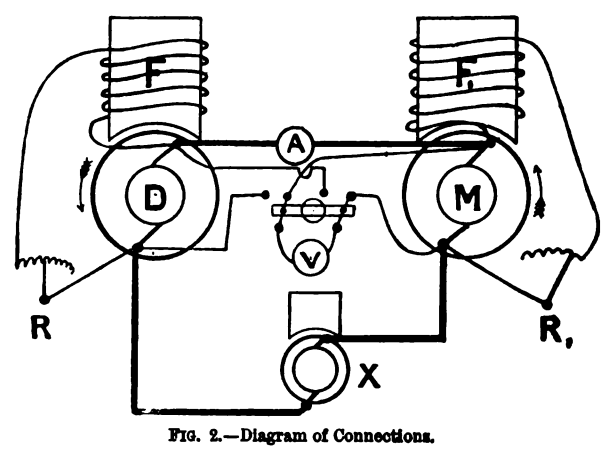

FIG. 2.—Diagram of Connections.

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1·42 × ·92 = 1·3 per cent.

Then 184 × 101·3 = 186·4 volts will be the figure corrected for belt-slip.

The efficiency of the combined set is then obtained by simple proportion.

215 : 186·4 :: 100 : x, from which $x = 86·7$ per cent., and the individual efficiency is then the square root of this, which gives the high figure of 93 per cent. as the commercial efficiency of each machine. The rheostats were then readjusted, so that the motor gives 150 b.h.p. to the driving belt, and the run continued for 24 hours. The following readings were taken at intervals, being a continuation of the previous table:

Motor.			Generator.			Time.
Volts.	Amperes.	Revs.	Volts.	Amperes.	Revs.	
200	608	514	169	608	514	1.30 p.m.
200	608	515	169	608	514	2 15 ,,
199	600	502	168	600	495	2.45 ,,
200	595	503	169	595	497	3.15 ,,
197	580	520	167	580	490	8.45 ,,
198	600	510	169	600	490	9.30 ,,
200	608	506	169	608	500	10.15 ,,
203	608	510	172	608	502	12.15 ,,
204	608	509	172	608	508	11.15 ,,
201	605	508	170	605	506	—
199	590	508	168	590	502	2 30 a.m.
195	580	495	164·5	580	487	3.25 ,,
200	585	486	169	585	486	4.30 ,,
197	580	497	166	580	486	5.30 ,,
200	596	502	169	596	494	6.30 ,,
209	600	514	178	600	508	7 30 ,,
202	600	500	172	600	496	8.0 ,,
198	600	514	168	690	506	8.45 ,,
201	610	506	170	610	502	9.15 ,,

The motor was thus kept fully loaded throughout the trial, while the generator was slightly underloaded.

The temperature tests taken show that the heating of the armature had attained its maximum value long before this trial was completed.

Temperature Rise in Armature.

	Motor.	Generator.
After 6 hours' run	35deg. F.	41deg. F.
,, 12 ,,	75 ,,	60 ,,
,, 18 ,,	76 ,,	58 ,,
,, 24 ,,	74 ,,	63 ,,

At the end of the trial the temperature of the exciting coils on the magnets was in the motor some 53deg. F. higher than that of the surrounding air, and in the generator 39deg. F.

The above tests were carried out under the inspection of Mr. Farquharson, late of the Admiralty, on behalf of the buyers.

We congratulate Messrs. J. H. Holmes and Co. on the excellent results of this trial.

LOCATION OF GROUNDS IN ARMATURES, FIELDS, ETC.*

BY CLARENCE E. GIFFORD.

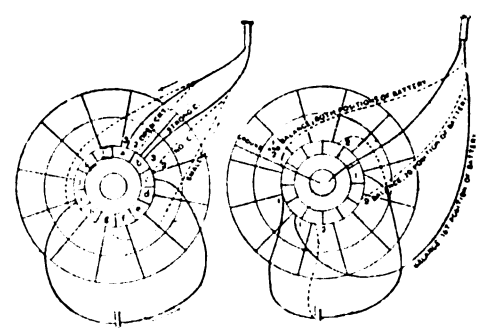
This paper presents no novel scientific principles. The methods herein described are but simple adaptations of the principle of the Wheatstone bridge. If the work can be performed in a very quiet room, two or three cells of battery, a telephone receiver, and connecting wires comprise the necessary apparatus. In some cases two "table binding posts" and a foot or two of No. 18 or No. 20 bright iron wire will be a convenient addition. Where noise will not permit the use of a telephone, a dead-beat reflecting galvanometer, a milli-voltmeter, or some other form of delicate and rapid working visual indicator must be used instead. If an armature is to be tested without removing it from the machine, connection with the battery may be made through the brushes, first making certain that the short-circuiting switch is opened, if dealing with an arc machine. The points of connection with the battery need not be diametrically opposite, and may be made by the wires being firmly pressed against the commutator by an assistant, if more convenient.

* Paper read at the twelfth general meeting of the American Institute of Electrical Engineers, Niagara Falls, N.Y.

Good electrical contact between metallic surfaces can better be secured by cleaning the same thoroughly with kerosene, which removes foreign matter, and is so fluid that it will in no way interfere with perfect contact when moderate pressure is applied. Especially when making measurement of resistance of armature sections, it is even advisable to have the surface of the commutator quite wet with kerosene during the operation, as this avoids trouble from grease or dirt which might get on the surface from handling, subsequent to cleaning, and it also prevents the contact points becoming oxidised by any sparks which may occur at the moment of breaking contact. True, the oil is an insulator, but we use it in this case as a detergent simply.

Returning to the armature, connection being made between battery and commutator, first determine whether the armature circuit is complete throughout. If the circuit is complete, a click will be heard in the telephone when the two terminals of the same are brought in contact with any two contiguous bars of the commutator, or when contact is broken. If an open circuit exists on either side of the circuit of course no sound will be heard in the telephone when used on that side, except when connection is made or broken by it between the bars lying on opposite sides of the break. (See Fig. 1.)

Close any open circuit temporarily by bridging between the two bars with a drop of solder. Two or more breaks can evidently be located by suitably shifting the battery contacts and searching as before. Open circuits will, of course, when an armature continues in work, soon cause burns between the bars that will indicate unmistakably their location. Having closed any open circuits, and the



Figs. 1 and 2.

battery being connected to two points of the commutator, approximately opposite each other, one terminal of the telephone is connected to the armature shaft, or frame of the machine, and the other terminal is drawn completely around over the surface of the commutator, while the telephone is held to the ear. If only one ground exists, two balancing points, or points giving the least noise in the telephone, will be found.

In an armature of ordinary construction, one of the points so found will be on the bar nearest the real ground, while the other balancing point bears what might be termed a "bridge relation" to the first, being at practically the same potential; the armature itself forming in reality a veritable Wheatstone bridge. Now shift the points of battery contact a few bars either way, and the true ground, if but one exist, will be indicated in precisely the same position as before, while the other balancing point will shift every time the battery contacts are shifted. (See Fig. 2).

If two grounds exist, two balancing points will be found, as before, but both points will shift more or less when the battery contacts are shifted, provided the grounds lie on opposite sides of the same battery contact. This case will be considered later.

In the case of one ground, having determined its location approximately, fix it as closely as may be by making and breaking contact with the telephone terminal on each of the more quiet bars, separately, until, by comparison, the two giving the faintest clicks are determined. If your hearing has served you correctly, these two bars lie nearest the trouble, the fainter one being the nearer. Prove the non-existence of a second ground by placing one of the battery contacts on the first bar to the right of the apparently

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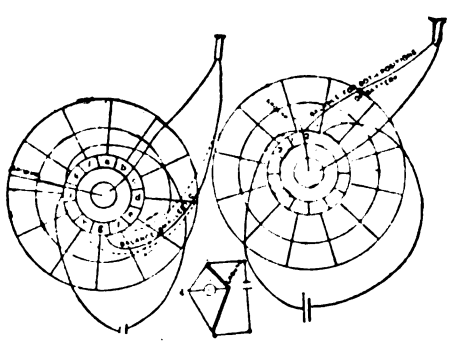
permanent balancing point just found, and then on the first bar to the left of said point, the other contact being nearly diametrically opposite. This balancing point should still remain unchanged if no other ground exists.

The next step is to connect the battery to these two bars just fixed upon as lying nearest the trouble. The armature still forms a "bridge," the portion included between the two contiguous bars to which the battery is now connected forming the one side, and the remainder of the armature the other side. (See Fig. 3.)

One of the telephone terminals is now connected to the shaft as before, and the other terminal again drawn around the commutator. If the balancing point is found, say, one-sixth to one-half the long way around from one battery contact to the other (these contacts being on two contiguous bars), the trouble lies in the coil between those two bars, and the point of trouble divides the coil in the same ratio as the balancing point divides the remainder of the armature, the ground and the balancing point being respectively nearest the same battery contact. If the balancing point falls on the same bar as one of the battery contacts, the ground is located on that bar or on the lead between it and the armature, provided the balancing point is found to be upon the same bar when the battery contacts are both shifted one bar to the right or left of their original position. (See Fig. 4.)

If the balancing point appears to be found within three or four bars from one of the contacts, the precaution should be taken to test its correctness by moving both battery contacts one bar toward the balancing point. If the trouble was between the battery contacts when in their previous position, this shifting of the contacts will now throw the balancing point clear around on to the contact, which was,



FIGS. 3 AND 4.

in the previous position, farthest away from the balancing point. If, on the contrary, the balancing point remains unmoved by this shifting of the battery contacts, it shows that this balancing point is the point nearest the real ground, and that the ear was deceived in its first supposed approximation, which, with due care, however, is not likely to occur.

If such error has been made, the new point, as indicated, together with first the bar on one side of it and then on the other, must be tried as points of battery contact, or, much better, make a new start with the contacts nearly at opposite sides of the commutator and proceed as before. A single 20,000-ohm ground on a one-ohm armature should be located accurately in not over three minues, in a quiet room. Higher resistance grounds require more battery and more care. Armatures of very low resistance also offer greater difficulty.

Where two grounds are found to exist, as indicated by the change of location of both balancing points, under the conditions before stated, when the battery contacts are shifted, the following mode of procedure will answer the purpose well, and is simple. Fix the battery contacts at any two points of the commutator nearly opposite each other, preferably at points to be determined by trial, that will cause the balancing points to fall nearly diametrically opposite to each other, and determine and mark the two balancing points, as then shown. Now place the battery contacts on the balancing points just found. If only one ground exists, the two balancing points and one battery contact will all be coincident in one point. If two grounds exist, both balancing points will be shifted from their former position. Open the armature circuit by unsoldering one of the ends of a coil connecting with the lead of the bar that is marked in the first part of this test, as one of the balancing points. Place one of the battery contacts on the armature shaft, and the other on the marked balancing point that is farthest from the point where the circuit has been opened. Next place one telephone terminal on the first bar to the right of the opened wire, and draw the other terminal from the same point toward the right, over the surface of the commutator. The telephone will be absolutely silent until the moving terminal has just passed the ground nearest to it, and strikes the first bar beyond the same, when it will click. This ground lies in the coil between this first bar giving a click and the one passed just previously, or else in the said previous bar.

The other ground is obviously to be located in a similar manner, by placing one telephone terminal on the bar just to the left of the open wire, and from that point searching toward the left with the other terminal. Only in cases where one ground is of very low and one of very high resistance will any difficulty be experienced in locating both accurately before either is removed.

The coils thus indicated may have their terminals unsoldered, when it can be readily ascertained with each whether the ground be in the coil or in the bar just preceding it.

If scientifically inclined, or if otherwise preferable, the circuit may be opened at a point somewhere midway between the two indicated coils instead of disconnecting those coils, and the exact location of each ground determined as follows: Take a piece of "broom wire" about 18in. long, new and clean, screw the ends firmly into two clean brass table binding posts, and into the other holes of the same posts screw the battery terminals. Have an assistant press the corners of the bases of the binding posts into very firm contact with the two bars that lie at the ends of the indicated coil, observing the directions previously given for securing clean contact. Place one telephone terminal in contact with the shaft, and with the other find the balancing point on the wire. This point will indicate the relative position of the ground in the coil or commutator bar, as the case may be. If more than two grounds were suspected, the two lying the farthest apart would be approximately located by the first part of the two-ground process, and if these coils were not disconnected before proceeding farther, it would be well to make two openings in the circuit, close to and lying between these outer grounds; then locate definitely these two extreme grounds and proceed with the remaining section somewhat as with a complete armature, except that you would commence by connecting the battery to the terminals of this section, and would then bridge the telephone from the shaft to the different portions of the section and would complete the process by applying the remainder of the two-ground test.

In dealing with a cross-connected Gramme ring, an obvious change would be made in the points of application of the battery, and as many points of apparent trouble would be indicated as there were series of cross-connections.

After location of these points it would be necessary to use the auxiliary wire loop, as before described, between these points, to determine which is nearest the trouble. This fact being determined, it would in case of a single ground (indicated by the permanency of the balancing point) become necessary to remove the cross-connections from two bars before proceeding farther. The auxiliary wire loop would properly be used to complete the process.

The ordinary "closed-coil" ring or drum armatures are types to which these methods are directly applicable.

The sections of open-coil armatures would receive the same treatment as field coils.

Familiarity with any special forms of armature will doubtless suggest to the ingenious mind modifications of these methods suited to those forms, but it would be improper to attempt here to deal with specialties whose names are legion.

Where wet grounds exist it will always be better, when practicable, to dry them out before making the final test, as certain sections may show faults which will not be permanent. Wet grounds will, of course, give a click in the

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telephone when bridged from the commutator to the shaft when no battery is attached, owing to galvanic action of the water on the copper winding and the iron core.

Whenever necessary to deal with wet grounds in testing, it is better to make at least four tests, reversing the battery after each test, and taking the mean of the four determinations.

Field coils, also any wires of uniform cross-section, the extremities of which are accessible and within a reasonable distance of each other, can, of course, be easily tested for grounds by soldering or firmly clamping a bare wire of suitable size between the extremities of the conductor to be tested, applying a battery to the junctions, and bridging with a telephone between the bare wire and the object upon which the conductor is grounded. This will give only the location of a single ground, or the "resultant" of two grounds. A "T. H." rheostat should have the battery connected to the two extremities, and the point of apparent ground determined by bridging with a telephone between the frame and the several contact plates. Then apply the battery to the frame and point of apparent ground, connect one terminal of the telephone with each extremity successively, and search from it toward the centre with the other terminal, as in the case of searching for two grounds in an armature.

In determining the location of grounds that are of very low resistance, a good induction coil similar to that used in the Blake transmitter may be used with advantage in connection with the telephone receiver. The receiver is placed in circuit with the secondary of the coil, and the "bridging" is done with the primary. With high-resistance grounds the best results are obtained by using the receiver only.

ASSOCIATION OF MUNICIPAL ENGINEERS.

A discussion followed Messrs. Christie's and Perry's papers read last week at the Londonderry meeting of the above-named association, and given in our last issue.

Mr. T. DE COURCY MEADE drew attention to the peculiar fact that the Londonderry lighting was for public lighting only, and that no provision had been made for private distribution. That policy differed from that of other municipalities, and, particularising Manchester, he pointed out that the whole power there was taken up in providing for public lighting, that extensions were being made, and he had no doubt these would be similarly utilised for private lighting. He thought the municipality was greatly handicapped by restricting its work in one direction only.

Mr. PRITCHARD (Birmingham) also considered it singular that the lighting was confined to street-lighting only. He agreed that arc lighting was the suitable light for large areas, while incandescent lighting was suitable for house or interior lighting. With regard to Mr. Perry's paper, he did not think that municipal engineers would generally become electricians or electrical engineers, but would allow the specialists to continue to work in that direction. The electrician, though, perhaps, not so bad as he was painted, generally tried to minimise his blunders by saying he was not a practical man, or, as Mr. Pritchard put it, "A'wm no practical." Referring to the use of electricity for traction, he gave his experience of accumulators—that they were far too costly and too fragile for the work.

Mr. LOBLEY (Hanley) said he could explain one or two of the circumstances referred to in the paper. In the first place, it must ever be remembered to the credit of Londonderry that the town was one of the pioneers in municipal lighting, and then when the scheme was entered upon by the Municipality no doubt more attention was given to the street than to private lighting. It was practically certain, however, that the latter must sooner or later be undertaken. It was a courageous thing for Londonderry at that early period to touch the subject at all, and he thought other municipalities owed a debt of gratitude to the city for showing them it could be done. Public lighting was an excellent advertisement and an inducement for private lighting. He did not agree with the present photometric measurement of lights in candle-power. The calling of an arc lamp 2,000 c.p. was misleading, and the same might be said of the ordinary gas-burner, which was 15 c.p. or 16 c.p. nominal only, not real. He thought that incandescent lamps might be useful in the back streets, but undoubtedly arc lamps must be used for the wide and busy streets. He agreed so far with Mr. Perry, that he thought the only man who should have the control of the streets for laying and repairing mains was the borough engineer. As regarded the cost of incandescent lighting compared with gas lighting at Hanley, the free library was wholly lighted by electricity, and it cost 15 per cent. more than when lighted with gas, but it was to be recollected that the amount of light was 50 per cent. greater. There was really no comparison between the two. Over his own desk he used to have two gas burners and could never get a good light; these he replaced by one 16-c.p. incandescent lamp, and his desk was now admirably lighted.

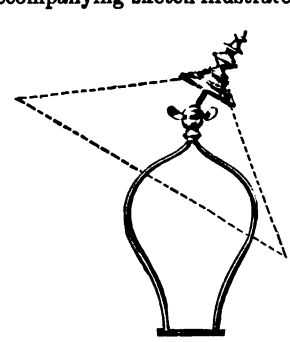
Mr. BROOM (St. Helens) thought that the borough engineer who undertook the design of a large installation would be a very courageous man.

Mr. CHRISTIE, replying to the speakers, said in Londonderry the electric light had replaced 550 gas lamps by 170 arc lamps. The cost of the gas-lighting was formerly £2,200 a year. He estimated that the working of the electric light would cost about £3,500 a year, including the repayment of the loan. To that had to be added £500 which they still had to pay for the remaining nearly 200 gas lamps, making £4,000 as against £2,200. Then it must be remembered that the streets were at least 20 times better lighted than they were formerly. Again, the gas formerly cost 3s. 10d. per 1,000ft. Since the electric light had been introduced that had been reduced to 3s. 7d. As to why they had public lighting alone, he was rather of opinion the two should be run in conjunction, and that it would have been better to have worked up the two together on a small scale in a central part and extended them as it became necessary.

Mr. PERRY explained that his remarks concerning electricians and engineers were from hearsay, and he willingly accepted Mr. Lobley's personal experience in the matter that—in the particular instance mentioned—the remarks might be in error. As regarded the borough engineer becoming an expert electrical engineer, he intended to imply that the borough engineer should be sufficiently well informed to take the lead and responsibility and control, leaving the design to the expert and the carrying out the details to the electrical engineer, whom he intimated should be an official subsidiary to the borough engineer.

NEW ELECTRIC LAMP SHADE.

A very neat shade-carrier attachment for electric lamps has just been put on the market by the General Electric Company, of Queen Victoria-street. The object of this fitting is to enable silk and glass shades, used with electric table lamps, to be canted or tilted in any direction without loosening screws or nuts. The usual carrier is used, but a universal ball joint has been introduced at the top which has the shade-fixing washers attached. The accompanying sketch illustrates the shade tilted,



and should the ball become loose with wear, it can be instantly tightened by screwing up the fly-nut shown. The fitting is provided at the bottom with 1⅛in. hole to suit the B.C. holders with shade rings. As the centre of gravity of the shade and support is nearly coincident with the ball and socket joint, the shade does not tend to cant over, even when the joint is not tightened up. For reading lamps this fitting will find a ready sale.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE TELEPHONE SERVICE.

The question put by Mr. Tully in the House on Tuesday elicited two items of interest—firstly, that the fate of British telephony is to hang undecided until next spring, and, secondly, that the Government has at present in view simply the appointment of a Select Committee to consider and report upon the evidence taken by Mr. Arnold Morley's Committee. We trust that more liberal counsels will, however, prevail when the time for deciding the scope of the new committee arrives. Our opinions on the telephone problem are well known. We believe that, given a monopoly, that monopoly should be a national one; for there is no eluding the fact that the present system has broken down in practice, and has procured for our country the reproach of being not only not foremost in telephony, but well-nigh last. This reproach is peculiarly hard to bear by the pioneers in the kindred art of telegraphy and by the countrymen of Bell and Hughes, who, without prejudicing the claims, as inventors or discoverers, of Bourseul and Reis, may justly be hailed as the most potent workers in the domain of practical telephony, for the one gave us the first practical receiver and the other the first really efficient transmitter.

But while advocating the transfer of the telephones to the State as being probably, on the whole, the best solution of an acknowledged difficulty, we deprecate any undue hurry or any disposition to move in that direction except on good, substantial, and well-ascertained grounds. The Post Office made a great mistake in 1870 when it paid too much for its telegraphs; it erred again in 1879 when it declined to welcome the newly-born telephone as an adjunct and supplement of the telegraph; and it was not too well advised when, subsequently and after its blunder had become manifest, it punished the public by putting obstacles in the paths of its own licensees, and so restraining the efforts which were certainly made to force the extension of the new convenience. Such frequent deviations from the path of what time has shown to have been the true policy tend to beget caution in even the most sincere friends and well-wishers of the permanent officials, and to accentuate the natural desire of business men that thorough investigation should precede action, in order that the edifice of error may not receive a final pinnacle. For this reason we think that public policy would not be served by limiting the next committee to the consideration of the evidence already taken. It must not be overlooked that the fairness of the late committee has been questioned in more than one quarter. Some of its members have been challenged as shareholders of the monopolist company; its chairman's zeal for Post Office acquisition is alleged to have somewhat blinded him to the true function of the committee, and to have betrayed him into an advocacy of the existing system which is not warranted by the state of public opinion. Certainly, witnesses were examined who had no pretensions to be considered telephonic experts, while the testimony of other gentlemen whose right to be heard cannot

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be gainsaid was rejected by—as the recently-published minutes of evidence show—the casting vote of the chairman. When the question comes up for final settlement, as it must do early in the ensuing year, we trust that there will be no desire to continue this line of conduct. The matter has to be reopened: let it be properly sifted. If the Post Office has a good case to present, as we believe it has, it should welcome, and not fear, the most drastic investigation possible.

The troubled sea of politics through which the bark of State has recently steered has dealt hardly with the late Telephone Committee, for submerged and beyond our ken as public men lie not only its chairman (Mr. Arnold Morley), but Sir Charles Cameron, whose thorough grasp of the subject was recognised by all; Mr. Fletcher Moulton, Mr. J. W. Benn, and Mr. Snape. The committee must, therefore, to a large extent be reconstituted, and advantage of the fact should be taken to exclude shareholders in the National Telephone Company and all others whose present interests or past connections render their perfect impartiality a matter of doubt.

CITY AND GUILDS EXAMINATION.

We have received a report from the gentleman who adjudicated on the papers sent in to us in answer to the questions set for the 1895 examination. He states that the students uniformly avoided the honours grade, evidently preferring to exhibit their knowledge by choosing the easier questions set in the ordinary and the preliminary grades. There has been some difficulty in judging fairly between the competitors, owing to a want of conciseness on our part when offering the prizes. Some have considered that our offer of books for the best set of answers to the paper meant that all the questions must be answered, in order that a complete set could be published. This was not our idea, as we wished the regulations printed at the head of the paper to be followed in every respect except as to time. The result has been specially felt in correcting the answers to the ordinary grade, where a number of really good sets of answers have been returned to us. We have, therefore, decided to give two prizes in this grade—one to the competitor who has answered the best set of eight questions, and one to the gentleman sending in the best complete set. The great fault running through nearly all the sets sent in has been, we are informed, in the sketches. These show that the students have not sufficiently exercised themselves in sketching the apparatus they see and use. This art, which cannot be too highly valued, can be acquired by most people if only care and time is given in the first few years of their professional career, and in after-life few acquirements will be found more useful in daily practice. The other error in detail is the average answers sent in by the competitors, and will be dealt with by our examiner.

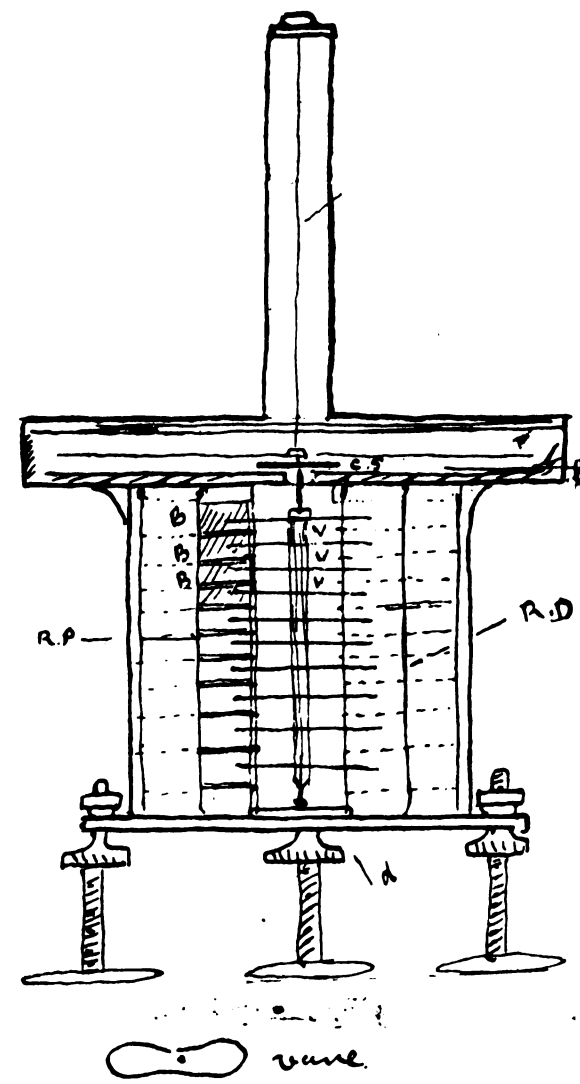
The two successful competitors in the ordinary grade are Mr. W. Shepherd, of Brockley, and Mr. E. B. Wedmore, of Bristol. We shall have pleasure in forwarding to each of these gentlemen any books they may select to the value of two guineas. The result in the preliminary stage will be published shortly.

The following is the set of answers sent in by Mr. W. Shepherd, of 41, Manor-road, Brockley. The examiner's notes or corrections to this individual paper have been curtailed as much as possible, and the errors common to several competitors will be discussed more fully in our next week's issue, when Mr. Wedmore's paper will be published.

ELECTRIC LIGHTING AND POWER DISTRIBUTION.

Ordinary Grade.

1. Describe and give a full-size hand-sketch of one of the modern kinds of electrostatic voltmeters.



Answer.—The figure shows a horizontal pattern of multicellular electrostatic voltmeter. A set of 10 aluminium vanes, V, are suspended by a fine wire suspension and separated by distance-pieces. The vanes are hung so as to rest in their normal position just outside a set of triangular brass quadrant boxes, B. A fine coach spring, C S, is placed between the vane spindle and the suspension wire; this saves the suspension from injury if the instrument is roughly set down. Two vertical brass repelling plates, R P, are fixed to the base; these also act as guards to prevent the vanes moving beyond the correct limits. The whole instrument is enclosed in a brass case, and mounted with levelling screws. A long aluminium pointer moving over a horizontal scale gives the volt readings which are correct for alternate current. A torsion head at the top of the case controls the zero. The sketch is one-third full size.

Note.—The principle of action should be described, and the reason of the multicellular construction explained.

2. What is the use of the series coil in arc lamps run in series with an unvarying current?

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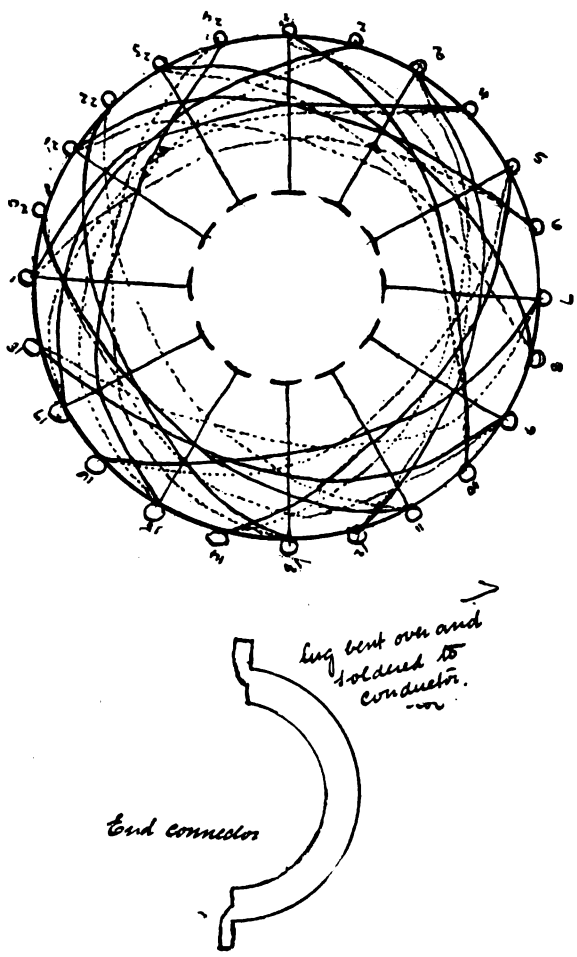
Answer.—The object of the series coil in constant-current arc lamps is to separate the carbons and strike the arc, maintaining it so long as the P.D. between the carbons is the correct amount. Should this increase owing to the arc becoming too long the shunt coil gets the mastery, and the carbons feed together.

3. Sketch a drum armature showing the connections and windings for 24 conductors on the outside. Sketch also any methods of end connection for drum machines in ordinary use.



Connect across $\frac{1}{2}$ (24) − 1 bars.
The dotted lines are the back connectors.

4. What are the advantages and disadvantages of running incandescent lamps at high efficiency?

Answer.—The advantages of working lamps at high efficiency are: (1) the first cost of installation will be less, as fewer lamps are needed; (2) a considerably increased light for a very small extra expenditure of power. The disadvantage is that the life of the lamp is very much shortened, and the cost for renewals becomes greater. As to which would be the most economical method of working, depends on cost of power, lamps, etc., at that particular locality.

5. Draw a solenoid showing roughly the lines of force before and after the introduction of a soft iron core.

Note.—Mr. Shepherd's sketch was much too rough for reproduction, and density, rather than direction, was shown by it.

6. How does slipping a copper tube over the core lessen the spark of an induction coil?

Answer.—Powerful eddy currents are set up round the copper tube, which directly opposes the primary field, thus weakening the effective induction through the secondary coil and diminishing the potential and spark.

Note.—It is the rate of change of induction which is most affected by the eddy currents. The E.M.F., being a function of the rate of change, is kept low, and hence the sparking is reduced.

7. How would you wind a medium-sized motor (say 10 h.p.) to run at constant speed with varying load? And how would you start such a motor?

Answer.—A shunt winding with a few series turns connected so as to demagnetise the field. To start the motor, switch the shunt across the mains, then the armature with the series turns reversed so as to assist the shunt. When speed has got up, the series coil is switched back in opposition.

Note.—More reasons for the statement should be given. Resistance should be used when starting.

8. What are foot-pound, poundal, dyne, and kilogram-metre? And how are they related?

Answer.—Foot-pound—The work done when a resistance of 1lb. weight is overcome through 1ft.; poundal—the force which acting for one second on 1lb. mass gives it a velocity of 1ft. per second; dyne—that force which acting on one gramme mass for one second gives it a velocity of 1cm. per second; kilogram-metre—the work done in overcoming one kilogramme weight through a distance of one metre.

One foot-pound = 13,825 centimetre-grammes;
$= 13{,}825 \times g = 1{\cdot}356 \times 10^7$ ergs (approx.),
where g is the acceleration of gravity in centimetres per second.

One poundal gives 1lb. an acceleration of 1ft. per second, or 453·6 grammes . . . . 30·48cm. per second. As a dyne gives one gramme 1cm. per second acceleration, ∴ a poundal = 453·6 × 30·48 = 13,825·73 dynes.

$$1 \text{ dyne} = \frac{1 \text{ erg}}{1 \text{ centimetre}};$$

1 kilogram-metre = 100,000 gramme-centimetres.
$= 100{,}000 \times g$;
or, $100{,}000 \times 981$;
$= 9{\cdot}81 \times 10^7$ ergs.

Note.—The methods and results are not clear.

9. If 10,000 kilocoulombs are passed through cells arranged in series containing solutions of Cu_2Cl_2, $Hg_2(NO_3)_2$, $CuSO_4$, H_2SO_4, and NaCl, how much copper, mercury, hydrogen, and caustic can be obtained?

Answer.—Weight in grammes = coulombs × electro-chemical equivalent.

Cu_2Cl_2 (cuprous chloride) 10,000,000 × ·00065419 = 6,541·9 grammes copper.

$Hg_2(NO_3)_2$ (mercurous nitrate) = $10^7 \times {\cdot}0020747 = 20{,}747$ grammes mercury.

$CuSO_4 = 10^7 \times {\cdot}00032709 = 3{,}270{\cdot}9$ grammes of copper.

H_2SO_4 (pure undiluted sulphuric acid) will not electrolyse. If mixed with water, then $10^7 \times {\cdot}0000\,10384 = 103{\cdot}84$ grammes of hydrogen are liberated.

NaCl $10^7 \times {\cdot}000\,23873 = 2{,}387{\cdot}3$ grammes of sodium.

In 40 parts NaOH there are 23 parts sodium;
∴ 23 : 2,387·3 : : 40 : x grammes caustic;
∴ x = 4,151·8 grammes caustic soda.

10. What are the advantages and disadvantages of the Planté and pasted plates for secondary cells?

Answer.—The principal advantage of the Planté cells is that they can stand rougher treatment, and take higher rates of charge and discharge without damaging the plates, than the Faure type. Their disadvantage is the longer and more troublesome formation needed to produce a good depth of active material on the plates. The advantages of the pasted plates are: (1) the short time and small expenditure of energy necessary for the formation of the plates; (2) the greater capacity for a given bulk of cell. On the other hand, the paste is apt to fall away from the plate, especially if the normal current is much exceeded; this may lead to short circuiting, besides loss of capacity.

11. What are the advantages of separate field magnets for the two armatures in continuous-current transformers?

No answer was given by the competitors.

12. A series dynamo has an armature resistance of 0·4 ohm and a field resistance of 0·6, and gives 120 terminal volts at a given speed and current of 10 amperes: work out its electrical efficiency as a dynamo and as motor at that speed and current.

Answer.—The total internal resistance of the machine is

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·4 + ·6 = 1 ohm. The volts lost internally = 1 × 10 amperes = 10.

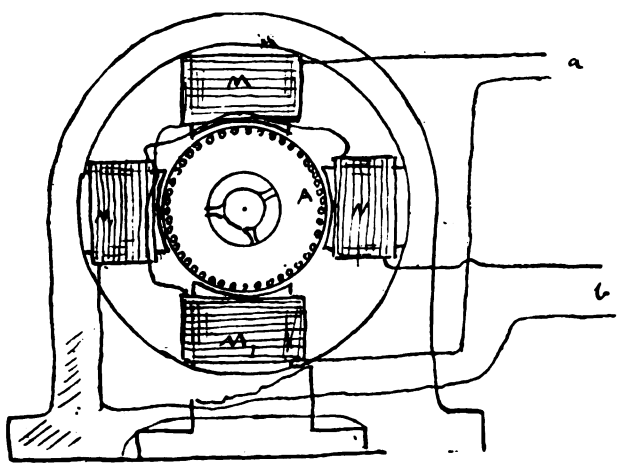
$$\therefore \eta = \frac{10 \times 120}{10 \times 130} = \frac{1,200}{1,300} = 92{\cdot}3 \text{ per cent.}$$

As a motor at same speed, the back E.M.F. will be 120 volts, and the terminal volts 120 + 10 = 130.

$$\therefore \eta = \frac{120 \times 10}{130 \times 10} = 92{\cdot}3 \text{ per cent., as before.}$$

Note.—The last part is wrong; the back E.M F. in the machine, at the same speed and field excitation, will be 130 volts—hence the terminal voltage will be 140, and the efficiency 92·8 per cent.

13. Describe one kind of alternate-current motor.



Answer.—The above is a rough sketch of a Ferraris rotary field motor. Two pairs of laminated magnets, M M_1 and N N_1, are excited from two separate alternating circuits differing by 90deg. in phase. The resultant action of these two oscillating cross fields is to produce one rotating field of almost constant value. The armature, A, is simply a drum with the conductors connected in parallel by massive copper end pieces. In order to reduce the air-gap, the conductors are passed through holes in the periphery of the core discs. Currents are induced in the closed armature by the revolving field, and a torque is thus produced which varies as the difference in speed between the armature and field.

14. When are alternate-current systems better than continuous-current systems? Give your reasons as fully as possible.

Answer.—When the distance between the station and points of distribution exceed about 1,000 yards it is more economical to use alternating currents, as high voltage can easily be used and the feeder mains kept a small sectional. The high voltage can be transformed down with facility for distribution. When the district is straggling, alternating currents of high tension would be the best, as transformers may be used to reduce the volts as required, and these need no attention. For transmission of power over long distances, or in any case where a very high potential is required, this can be best produced by alternators, as they can be more easily and safely constructed to bear the strain than continuous-current machines. Lastly, in cases where skilled labour is scarce, alternating plant may be better, as regulation and management is simpler, there being no large commutators to look after.

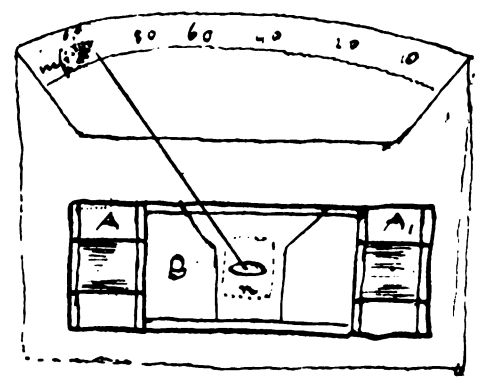
15. What peculiarities are there in the design of a dynamo for supplying arc lamps in series at (say) 3,000 volts?

Answer.—Dynamos for supplying arc lamps in series are usually of the open-coil type with ring armatures. Great care is necessary in insulating the armature coils from each other and from the core, and in some cases the whole machine is insulated from the ground. In the commutator there are many peculiarities, the principle being the fewness of the segments and the heavy insulation between them. The armature coils are consequently few in number and their self-induction considerable, but this is an advantage. Multipolar fields are frequently used, the magnets being worked at a high induction. They are series wound, and there is some mechanical or electrical device for automatically keeping the current constant, either by shifting the brushes or by varying the field excitation.

17. What is your idea of the advisability of earthing the secondary in transformer systems?

Answer.—Although all danger of a shock from the high voltage may be avoided by well earthing the secondary coil, it is not advisable to do so, as there would be a constant strain on the insulation of the system, and should a fault actually occur the leakage might be serious, with, perhaps, a total failure of current. A safety device, which only earths the house circuit, if the potential between it and the earth assumes a dangerous value, is preferable.

18. What is the construction of an ohmmeter?



Answer.—In the ordinary form of ohmmeter represented in section above, there are three coils—two, A A_1, being wound in a vertical plane parallel to each other, while the third one, B, is wound in a plane at right angles to the first. At the common centre of the three coils is a small steel needle moving horizontally, the coil B being cut away to give the pointer a wide range. The coils A A_1, which are of high resistance, are coupled in series, and connected to some source of fairly high E.M.F., while B is placed in series with the resistance to be measured and the same E.M.F. Any current through B will give a deflection to the needle, which is read off the scale in megohms. Under the instrument is a small magnet to counteract the magnetic force of the earth.

19. Why does an electromagnet spark on breaking the exciting circuit?

Answer.—When the circuit is broken the lines of force round the magnet suddenly collapse, cutting the exciting coil, and inducing an extra current of high potential in the same direction as the exciting current. This tends to keep up the current, although the circuit is broken, and a spark results.

20. How are the pull and self-induction of an electromagnet connected?

Answer.—The self-induction of an electromagnet for unit current = L = $\frac{4\pi\mu a t^2}{l}$ absolute units. a = area of coil in centimetres; t = turns; l = length. The pull is expressed by $P = \frac{B^2 \times a}{\delta\pi}$ dynes.

Now $B = \frac{4\pi t \mu}{l}$ for unit current;

$$\therefore L = B a t;$$

$$\therefore \frac{P}{L} = \frac{\frac{B^2 a}{\delta\pi}}{Bat}$$

or, $$P = \frac{L B}{\delta\pi t},$$

which expresses the relationship.

21. A condenser having a capacity of two microfarads is connected to two terminals maintained at 2,000 volts; how

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much work is taken from the terminals, and how much can be got out of the condenser again?

Answer.—Work taken up $= \frac{K V^2}{2}$ joules, where K is in farads and V in volts. Or in this case

$$\frac{2 \times 10^{-6} \times 2{,}000^2}{2}$$

$$= \frac{2 \times 10^{-6} \times 2 \times 10^6}{2} = 2 \text{ joules},$$

or, $$\frac{4}{2{\cdot}712} = 1{\cdot}475 \text{ foot-pounds.}$$

The condenser will give back this amount of work again, if there is no leakage.

22. What magnetic quantities are denoted by the symbols H, B, and μ; and how are they related to one another?

Answer.—H denotes the intensity of a magnetic field surrounding a magnet. It is measured at any point by the mechanical force which a unit pole experiences if introduced into the field at that point. B is the magnetic induction or number of lines of force per unit area passing through a material placed in a magnetic field. μ, the permeability of a substance, or its relative conductivity for lines of force compared to air.

$$B = \mu H;$$

$$\mu = \frac{B}{H};$$

$$H = \frac{B}{\mu}.$$

23. Given a ring armature 10in. long, 10in. diameter, 1in. radial thickness of iron, what wire would you use to give 110 volts, and what current would be suitable? Speed, 1,000 revolutions per minute.

Answer.—

Ring armature, 10in. long;
10in. diameter, 1in. depth of core;
110 volts;
1,000 revolutions a minute.

Assuming as a fair induction 14,000 lines per square centimetre. The cross-section of armature core $= 10 \times 2 = 20$ square inches $= 129$ square centimetres.

Then $$110 = \frac{C \times 129 \times 14{,}000 \times 1{,}000}{60 \times 10^8},$$

or, $$C = \frac{110{,}000}{301} = 362 \text{ as nearly as possible.}$$

$\therefore$ number of external conductors needed $= 362$.

The circumference of core $= 10 \times \pi = 31{\cdot}4$in.

$$\frac{31{\cdot}4}{362} = {\cdot}0867\text{in.} = \text{diameter of insulated wire.}$$

Allowing 15 mils for insulation, this leaves ·0717in. as the diameter of copper wire = about No. 15 S.W.G. This would allow eight amperes at 1,000 per square inch, or 16 amperes as output of armature.

If wound in two layers

$$\frac{31{\cdot}416}{181} = {\cdot}1735\text{in. diameter of wire.}$$

Giving 20 mils for insulation, this leaves 153·5 mils for the diameter of wire. This, at 1,000 amperes per square inch $= 18\frac{1}{2}$ amperes, or 37 as the total current.

Note.—A higher induction in the iron core could be used, but allowance must be made for the paper insulation in working out the section of the core. Not more than 90 per cent. of the gross area of the laminated core will be iron. Again, a much higher density of current in the copper conductor can be used, and this competitor should work rather to watts wasted per square inch cooling surface than to density.

SOME USES OF CURVES IN ELECTRICAL PRACTICE.

BY H. H. SIMMONS, A.I.E.E.

(Continued from page 148.)

In Fig. 10 are given some well-known curves, such as the circle, the ellipse, and the parabola. The equations to these curves, or, as they are often called, the laws of these curves, as drawn, are written on them, and the constants used are given below:

Circle: $x^2 + y^2 = a^2$. $a = 4$.

Ellipse: $\frac{x^2}{a^2} + \frac{y^2}{b^2} = c$. $a = 9$, $b = 4$, $c = 1$.

Parabola: $y = K\sqrt{x}$. $K = \sqrt{10}$.

These laws are for the curves in the positions drawn in Fig. 10; if the origin were changed we should have to

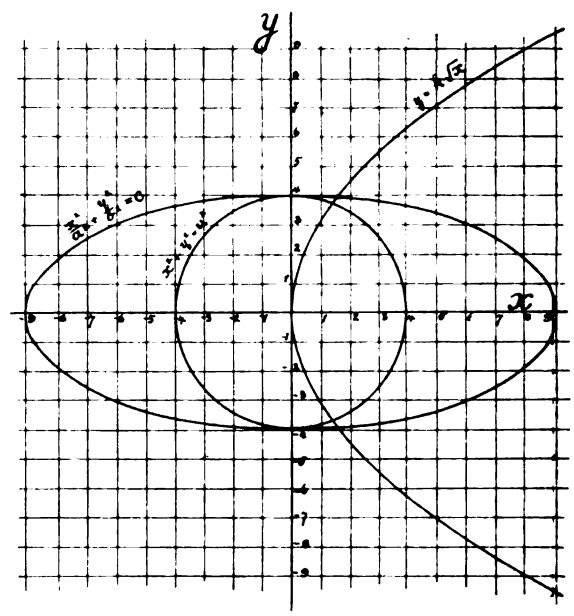

FIG. 10.

make a corresponding change in the law—for instance, if the centre of the circle were not in O, its law would be $x^2 + y^2 - 2ax - 2by + a^2 + b^2 = r^2$, where a and b are the X and Y ordinates respectively of the centre, and r = the length of the radius.

In Fig. 11 are shown two hyperbolas. The one whose law is $xy = a$ being of interest in practice, in that it is the curve which results when, on a dynamo characteristic, we join points of equal horse-power: x may represent amperes and y volts, while a is the number of watts, the product of the two.

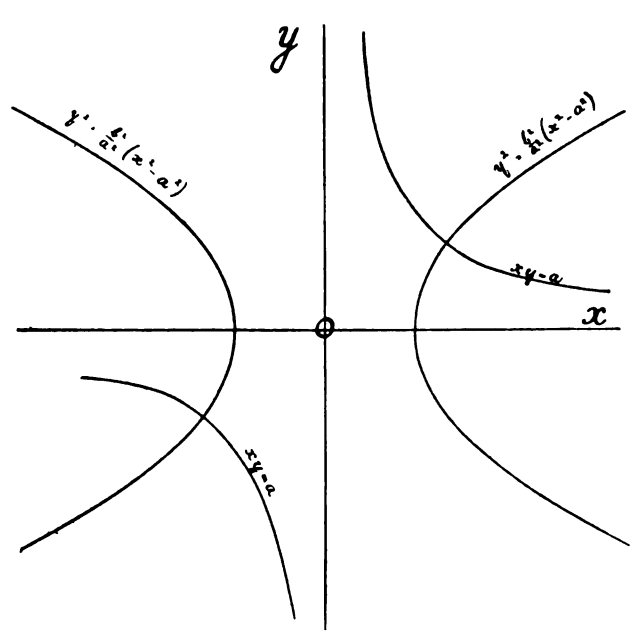

FIG. 11.

We have now had before us the basis and procedure of all curve plotting by rectangular co-ordinates, and have arrived at the point in theory beyond which it is impossible to proceed without at least some knowledge of elementary mathematics. We are not debarred from gleaning considerable information, however, from the curves in common use in practice.

Perhaps to the man who has never troubled his head

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about more than he could help, the curve showing the output of a dynamo at constant speed is the most familiar. It is presumably unnecessary to remark that, although an approximately constant speed is common enough for dynamo driving, an absolutely constant speed is the reverse of common. In Fig. 12 is given the characteristic—*i.e.*, output curve—of a series machine. This is obtained when the speed is kept as constant as possible, and the resistance of the magnet coils and armature windings are as nearly so as may be, the whole temperature of the machine being assumed constant.

In this figure we have three distinct curves drawn, to which are attached the letters E, V, and I respectively. The curve V is that connecting the voltage at the terminals of the machine and the current in the external circuit, that marked E connecting the internal E.M.F. with the external current, and I having special reference to the internal resistance of the machine, as will be seen further on.

The curve V is obtained, as must be well known, by taking simultaneous measurements of the pressure at the terminals of the machine and the current going to the external circuit. Pressure, or voltage, is then (by unanimous consent to follow Dr. Hopkinson, who in 1879 originated the practice) plotted to a vertical scale, while current is plotted horizontally. This places before us a concise representation of the capabilities of the machine, far easier to follow than any two rows of figures, and far more handy to deal with, as we shall see. Let us endeavour to find what the internal E.M.F. of the machine is at any

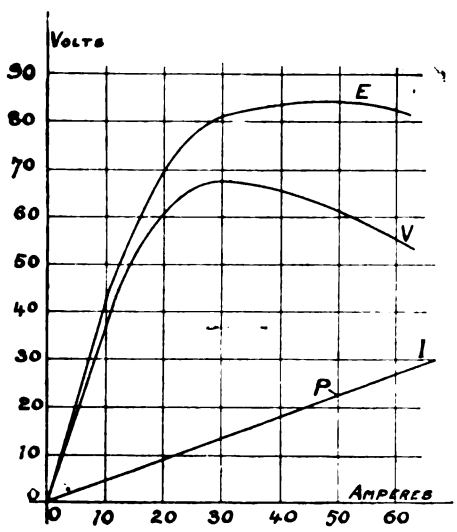

Fig. 12.

output. We know that it is the terminal E.M.F. plus the volts lost in the internal resistance of the machine. If this internal resistance be 0·45 ohm, then to get the volts wasted in this resistance we have to multiply this at every point by the current flowing. This is easily done on the curve by drawing a suitable straight line. From our previous article we know that $mx=y$ is a straight line through O, the origin, and so, to multiply x or y by a figure m, we have only to draw such a line—as for instance, O I, in which 0·45 × current = volts; thus at 50 amperes we have a point 22·5 volts. It is easy to see that the greater the internal resistance the greater the slope of this line, O I—*e.g.*, if it were 0·5 the point, P, would be (at 50 amperes) 25 volts, and if the internal resistance were 0·6 ohm the point at 50 amperes would be 30 volts.

The slope of this line is evidently then a figure representing the internal resistance of the machine. If our scales for volts and amperes are equal, as is rarely convenient, the tangent of the angle I O X gives this figure; if the scales are unequal, we must of course read the values on those scales and divide volts by amperes to get resistance. We now have merely to add to the height of the curve V at every point the height of the points on I at the same currents, in order to obtain the internal E.M.F. of the machine. This has been done on the diagram, and the Y ordinate (or volts) of any point on the curve E is equal to the sum of the Y ordinates (or volts) of the points on V and I at that same current.

TESTS OF A POLYPHASE MOTOR.

BY D. C. JACKSON.

We hear much in these days in regard to the advantages of two-phase and three-phase alternating currents for the transmission of power, but comparatively little information is obtainable in regard to the actual performance of the motors, as shown by impartial tests that may be relied upon. The records of independent tests made in Switzerland, Germany, and France are to be found in various foreign periodicals and in the journals of foreign engineering societies, but very few such records are found in English printed journals. Dr. Louis Bell has given us much information based upon his experience in regard to the performance which may be expected of polyphase induction motors, and Mr. Steinmetz has, from time to time, added much to the general fund of knowledge bearing on their design and performance. Complete tests of American polyphase motors are not presented to us by these gentlemen, though Dr. Bell has given some interesting comparisons between alternating and continuous current motors. The comparative curves which he gives seem to be almost the only ones which have been presented in America. On this account the results of tests made upon a three-phase motor at the University of Wisconsin are of interest.

Particular interest attaches to polyphase motors at this moment because the manufacturers of polyphase machinery are pushing beyond the boundary of long-distance transmission of power into the field of the distribution of power in factories—inter-machine distribution, as it may be called. In the latter work the polyphase motor enters into direct competition with the continuous-current motor, and the

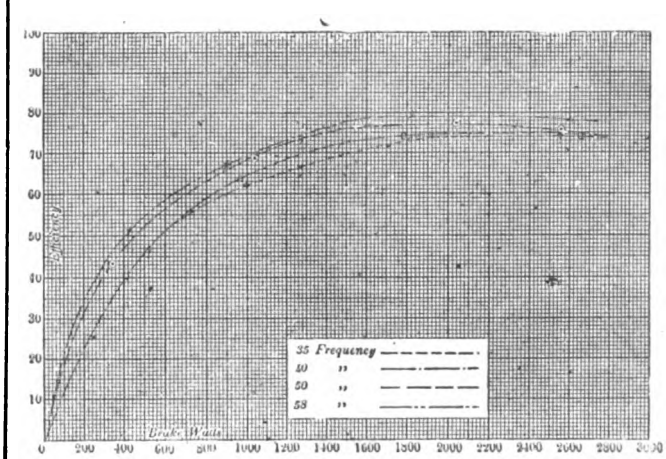

Fig. 1.

performance of machines of small size must be particularly excellent if they can take an equal place with continuous-current motors. For long-distance transmission of power the alternating current presents such remarkable transmission advantages that defects may be overlooked in the motors which would condemn them for use in inter-machine distribution, where economy and close regulation on the part of small motors are factors of the greatest importance.

The motor for which tests are here given belongs to the dynamo laboratory of the University of Wisconsin, and is used for testing in the regular course of laboratory instruction. It was made by the Allgemeine Elektricitats Gesellschaft, of Berlin, Germany, in 1893. Its rated power is from 3 h.p. to 5 h.p. at a speed of 1,500 revolutions per minute, which is the theoretical speed which it should attain at a frequency of 50 (6,000 alternations per minute). The fields of the motor are "mesh" wound for a pressure of 100 volts between the leads, and the armature is of the common "squirrel-cage" type—that is, the armature conductors consist of straight rods threaded through holes close to the periphery of the armature core, all the conductors being connected together at each end by copper short-circuiting rings. Tests of the motor have been made with a wide range of frequencies, the triphase current being furnished by means of a rotary transformer which furnishes a convenient means of getting three-phase currents of any

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desired frequency between 35 and 60. The alternating current developed by this rotary transformer is probably quite close to sinusoidal. The transformer is limited in its current-carrying capacity, and the motor has therefore not been tested beyond about 3·6 b.h.p. In testing,

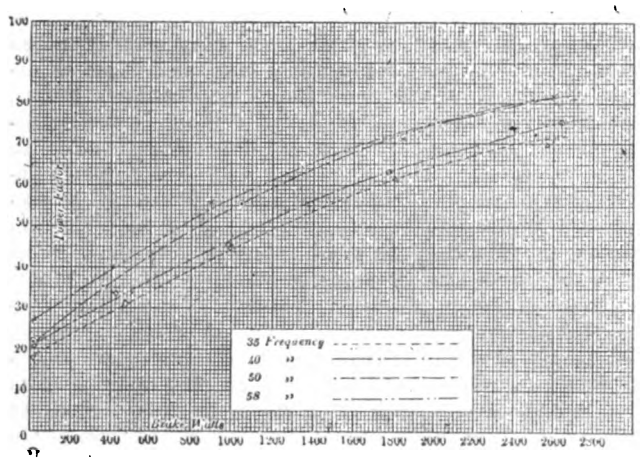

FIG. 2.

the output of the motor has been measured by means of a Prony brake, the input by means of a Weston or an electro-dynamometer wattmeter, the current in each circuit by means of an electro-dynamometer, the pressure between the three terminals and the centre

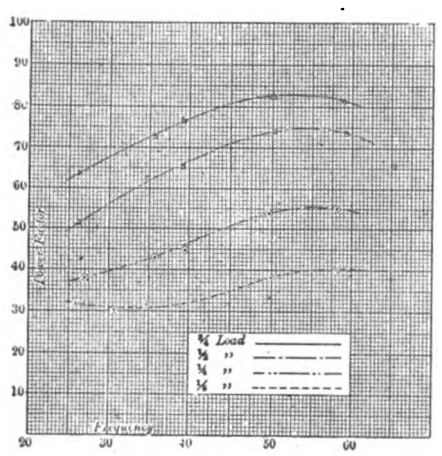

FIG. 3.

of the mesh by a Weston alternating-current voltmeter, all being carefully standardised.

The results are given graphically in Figs. 1, 2, and 3. Fig. 1 shows efficiency curves for the motor when driven at frequencies of 35, 40, 50, and 58. The revolutions per

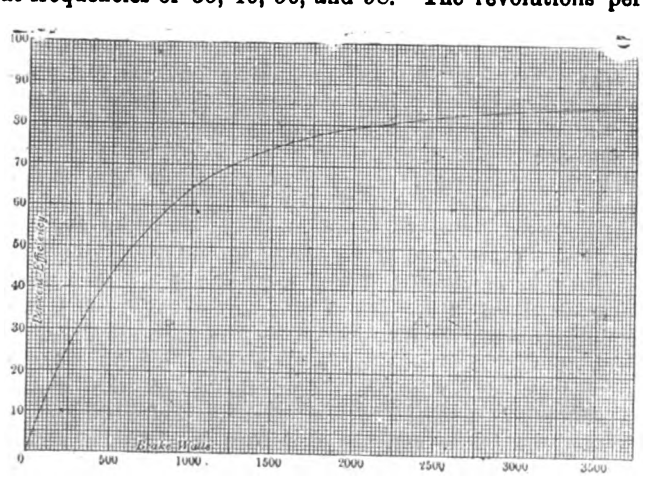

FIG. 4.

minute made by the armature of this motor are theoretically 30 times the frequency, or one-fourth the number of alternations per minute. Consequently, the theoretical test speeds corresponding to the curves in the figure are 1,050, 1,200, 1,500, and 1,740 revolutions per minute. The efficiency of the motor over the whole range of frequencies is very good, and in comparison with Fig. 4 it may be said upon the whole to compare favourably with the corresponding efficiences of a continuous-current motor. Fig. 4 is an efficiency curve taken from a 5-h.p. continuous-current motor of a well-known manufacturer. The drop in speed of the alternating-current motor between no load and full load is about 7½ per cent. at the best frequency, while the regulation of the continuous-current machine is almost perfect.

Fig. 2 shows the variation with load of the power factor (ratio of wattmeter reading to product of ampere and volts) at the four frequencies, and Fig. 3 shows the relation of power factor to frequency at different loads, counting full load as 5 b.h.p. It will be seen from these curves that the highest power factor does not much exceed 80 per cent., and that this motor must always demand upward of 20 per cent. more current from the generator which supplies it than is actually represented by the motor's output.

Results of tests of a similar motor are reported in *L'Industrie Electrique* for May 10, 1893, and agree quite fully with the results just given. The general results are condensed into the attached table:

TESTS—*L'Industrie Electrique.*

Motor.	Type.	H.P.	Max. h.p. at test.	Max. eff. Per cent.	Drop in speed at full load. Per cent.
A.E.G. three-phase...	DR 50	5	5	84	6½
	Wisconsin University.				
A.E.G. three-phase...	DR 50	5	3 6	80	7½
Continuous current...	—	5	5	85	0

It is unfortunate that the test on the alternating-current motor could not be made upon an American machine of one of the types now coming into use, but there has been none available for the work. The American machines have the same general constructive characteristics as the motor tested, and are likely to differ but little in their performance. The curves show a greater advantage to the credit of the continuous-current motor than is given it by Dr. Bell.

METALLIC LACTATES FOR ELECTRO-PLATING.

In connection with a paper on the electrolytic deposition, for analytical purposes, of metals dissolved as lactates or glycolates, Dr. Jordis, of Munich, pointed out that lactic acid provides an excellent solvent for electro-plating. As yet experiments have only been made in the laboratory with plates of 30 square inches surface. The deposits form so uniformly and easily, however, and adhere go well, that there is great hope for technical processes based upon Dr. Jordis's researches. The expensive free lactic acid is not required. In Germany lactic acid is quoted at 590 marks—as many shillings—per 100 kilogrammes (220lb.); a fairly pure acid can be obtained for 300 marks, while pure lactates of calcium and zinc, from which the acid is generally separated, cost 190 and 435 marks. Coatings of copper and brass of varying shades on iron, zinc, or copper, of zinc on iron and copper, and of iron and of nickel can be obtained without difficulty, without any special apparatus. Whether the latter point will be confirmed in operations on a larger scale remains, of course, to be seen. As to zinc, Dr. Jordis does not appear to have been particularly successful. In any case the process has great interest for engravers, whose blocks are not as a rule of large dimensions, and particularly for the silver-plating industry. Amalgamated brass is, in a bath of lactate of silver, covered with a pure white coating of silver, which takes the highest polish. It would be a great boon if we could replace the dangerous cyanide of potassium by the harmless lactic acid. The connection with milk might suggest bacteria, as the decomposition of the lactic acid into carbonic acid and acetal aldehyde need not, in the vat, proceed as certainly as it does in platinum dishes. But lactic acid is itself regarded as antiseptic, and the electric current, though perhaps not so fatal to micro-organisms as is often asserted, does not favour their development. The communication was brought before the recent second annual meeting of the Deutsche Elektrochemische Gesellschaft at Frankfort-on-Main,

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LIGHT RAILWAYS AND TRAMWAYS.*

BY R. H. DORMAN, M.I.C.E., COUNTY SURVEYOR, ARMAGH.

So much has been written regarding light railways and tramways during the past few years that it is difficult to prepare a paper containing any new matter on these subjects. It is probable, however, that nearly all the members of this association are called on occasionally to report in some way or another respecting their construction, and it is therefore to be hoped that the few remarks which the author proposes offering may give rise to an interesting discussion.

The author has thought it advisable to confine his remarks chiefly to light railways and tramways as constructed in this country. Although he was engaged for some time on railway work in England, and superintended the construction of the Highgate-hill Cable Tramway for the Hornsey Local Board, he is better acquainted, and has been connected for the greater part of his life, with work of this kind in Ireland. It is not proposed to deal with the lighter descriptions of tramways—namely, such as might be laid down in order to connect a series of farms with a neighbouring town. Such tramways are not required at present, and probably never will be required in this country.

A light railway in Ireland is defined by the 31 and 32 Vict., c. 119, as a railway on which the weight of one pair of wheels of the engine does not exceed eight tons, and the speed adopted does not exceed 25 miles per hour. The chief difference between a light railway and a tramway appears to be that a light railway is run over land which is specially acquired for the purpose, while a tramway runs over or alongside a public road, and the speed is limited to 12 miles an hour in the country and to six miles in towns and villages.

Light railways and tramways in this country may be classed as follows:

1. Light railways both of the ordinary 5ft. 3in. gauge and narrow gauge. The line known as the Bessbrook and Newry Electric Tramway should be properly classed as a light railway, as it runs over specially acquired land all the way, except where it crosses the public roads.

2. A composite type. Those which run for part of their course over specially acquired land, and for part of their course along the public road.

3. The Lartigue system.

4. Tramways of various gauges and worked by steam, by electric power, by a combination of steam and electricity, and by horses.

The light railways and tramways in Ireland have been constructed:

1. As feeders to existing main lines.

2. To open up tracks of country through which no railways run, and in which there is no probability of heavy trunk lines ever being constructed.

3. Horse tramways in the larger towns.

4. Short lines for the accommodation of special industries.

The capital for the construction of the fourth class has usually been obtained from private sources, and for the third class it has been obtained in the open market. Previous to the Act of 1883 the capital for the first and second class was obtained by the barony, or baronies, through which the line passed, giving a guarantee for a portion of the capital, generally for a limited number of years, afterwards ratified by a special Act of Parliament, which also authorised a loan from the Board of Works and the issue of ordinary shares. In 1883 a special Act of Parliament was passed by which the Treasury guaranteed to the county a maximum of 2 per cent. when the grand jury gave a guarantee of 4 per cent. or more; this Act also conferred powers for the compulsory purchase of land, and did away with the necessity of obtaining a special Act for each particular line. A considerable stimulus to the construction of light railways and tramways was given by this Act, but it is to be regretted that the 2 per cent. guarantee given by the Treasury was not made a direct guarantee. If a direct guarantee of 3 per cent. were given by the Treasury, a portion of which would of course be raised by the county, it would be as easy or easier to find the necessary capital for the construction of a line than it is now with a guarantee of 4 or 5 per cent. from a grand jury.

As a general rule the light railways of the ordinary gauge are worked, and the rolling-stock or part of it provided, by the railway company to which the light railway forms a branch, or of which it is an extension, for a percentage usually 50 to 55 per cent. of the gross receipts. A working agreement of this kind is always favoured, and sometimes insisted on, by the Treasury as some security that a line will be kept open. Instances of railways having been opened for traffic and afterwards abandoned have occurred; as, for example, the Parsonstown and Portumna Railway, the rails, sleepers, and even the station building of the railway having been appropriated and removed by the country people. It may be mentioned here that the majority of these railways have at first proved anything but remunerative, and in some cases the receipts have proved insufficient to meet the working expenses; but almost invariably the receipts are found to increase annually, and in some cases these railways are now able to pay not only the baronial charges, but also a dividend on the ordinary shares, or a contribution to the baronies, as specified in Section 5, c. 43, 46, and 47 Vict. This result proves that increased traffic is created by the construction of these railways in the districts through which they run, and the ultimate benefit to these districts can hardly be over-estimated.

Gauge of Light Railways and Tramways.

The great majority of engineers in this country favour the adoption of the Irish 5ft. 3in. gauge, and with good reason. Railways in this country can generally be constructed easily and cheaply; they are to a great extent surface lines, and as a rule no expensive works are required in connection with them. By the adoption of the narrow gauge there would doubtless be a slight saving in the cost of land, in masonry works, in earthworks, and in ballast, but there would be no saving in the promotion of the scheme in the first instance, nor in station buildings, nor in fencing, nor in signalling, etc., and not much saving in maintenance and working expenses, while the advantages of being able to interchange rolling-stock with other lines far outweigh the slight saving in cost effected by adopting the narrow gauge. Moreover, the rolling-stock adopted for narrow-gauge railways is not suitable for the conveyance of cattle, one of the most important items of traffic over Irish lines.

In the case of tramways the gauge which should be adopted is more difficult to decide. For tramways running along the side of a public road, in which case the rails need not be kept on a level with the surface of the road, a 3ft. gauge will probably be found the most suitable; a greater width of roadway (which must not be less than 18ft.) can thus be left than if a wider gauge were adopted, and sharp bends in the road can be manipulated more easily. In the case of tramways running over a central track, the 4ft. 8½in. or 5ft. 3in. gauge is usually considered the most convenient.

Curves and Gradients.

For light railways of the ordinary gauge the sharpest curve usually adopted is 10 chains, but I have occasionally known curves as sharp as seven chains put in. For light railways of the 3ft. gauge curves as sharp as 2½ chains are sometimes tried, and on tramways of the same gauge curves of one-chain radius can be worked round. At each terminus of the Bessbrook and Newry Tramway (3ft. gauge) there is a loop of 55ft. radius, round which the cars are easily worked in order to avoid the necessity of reversing them; it should be remembered, however, that these cars are of the bogie type. Gradients steeper than 1 in 30 are seldom adopted in this country on railways and tramways worked by mechanical means, and considering that, owing to an unfortunate clause in the Act 31 and 32 Vict., the weight on one pair of wheels of any engine shall not exceed eight tons, it is evident that only light trains can be taken over a gradient of 1 in 30. If anything in the shape of heavy

* A paper read before the Incorporated Association of Municipal and County Engineers at Londonderry.

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traffic is anticipated, the gradients should not, if possible, exceed 1 in 60.

Cost of Construction.

The cost of constructing and equipping a light railway or tramway has been variously estimated at from £1,000 to £10,000 per mile, and a few tramways have been constructed in England at a cost of about £1,000 a mile, but I think the lowest at which any tramway has been constructed and opened for passenger traffic in this country is £1,800 per mile, the approximate sum at which the Warrenpoint and Rostrevor Tramway, 3 miles 20 chains in length, was constructed. Probably, no light railway has been constructed and equipped in this country at less than £3,000 per mile; perhaps the cheapest line which has come under my notice is a branch of the Cavan, Leitrim, and Roscommon Light Railway and Tramway, from Ballinamore to Drumshambo, which is stated to have cost only £3,100 per mile. The gauge of this line is 3ft.; weight of rail 45lb.; weight of engines 20 tons when empty; steepest gradient 1 in 30, and sharpest curve 250ft. radius. The engines are specified as being capable of taking a train of 100 tons up a continuous incline of 1 in 40 for one-third of a mile, with curves of 10 chains radius.

A few other examples may be given showing the comparative cost, etc., of light railways and tramways in Ireland. The Castlederg and Victoria Bridge Tramway (7 miles 12 chains), 3ft. gauge, cost slightly over £3,000 per mile. The Portstewart Tramway (1 mile 68 chains), 3ft. gauge, cost slightly over £3,000 per mile. Schull and Skibbereen Railway (14 miles)—gauge 3ft., weight of rail 45lb., steepest gradient 1 in 30 for a distance of one mile, sharpest curve 2½ chains—cost £4,000 per mile. When this line was first opened for traffic four engines were provided, one only being of the bogie type, the remainder stiff, which, however, proved very unsatisfactory. Clogher Valley Light Railway and Tramway (37 miles 3 chains)—gauge 3ft., weight of rail 45lb., steepest gradient 1 in 30, sharpest curve (in the town of Caledon) 1½ chains, on private land, sharpest curve 4 chains—cost about £4,000 per mile. Clonakilty Extension Railway (8 miles)—gauge 5ft. 6in., weight of rail 65lb., steepest gradient 1 in 70, sharpest curve 15 chains — cost about £4,500 per mile. Although this line cost such a small sum to construct, it can hardly be classed under the head of a light railway, and it was not constructed under the Act of 1883, but under a special Act.

I should mention that all the above lines are worked by locomotives except the Warrenpoint and Rostrevor Tramway, which is worked by horses, and also that the estimates given include the cost of rolling-stock, except in the case of the Clonakilty Extension Railway, which is worked by the Cork and Bandon Railway for a percentage of the gross receipts.

Method of Construction.

The method of construction is usually pretty much the same for light railways and tramways of the kinds mentioned above. The rails are of the Vignoles section, weighing from 45lb. to 65lb. to the yard. The sleepers for narrow-gauge lines 6ft. by 8in. by 4in., for ordinary gauge 9ft. by 9in. by 4½in.; both creosoted and uncreosoted are used, generally rectangular, but sometimes half round. The sleepers are generally placed 3ft. apart centre to centre, and at the joints 2ft. centre to centre. As the traffic on these lines is not very heavy, the rails will last for a very long period without requiring to be renewed, but the life of the sleepers deserves consideration. Ten years is found a good average life for Baltic sleepers creosoted under pressure, but they will frequently be found sound after being in as long as 15 years. Six years would be a fair average for the same sleepers merely dipped, and five years if unprotected. Scotch fir sleepers will last about five years, and larch about eight years, but larch is not always obtainable. While on the subject of sleepers, I might mention that I had recently to inspect a short narrow-gauge line, on which very light wrought-iron sleepers were used, and they seemed very well adapted for their purpose. The rails are secured to the sleepers by dog-spikes; frequently fang bolts in addition are used at the ends of each rail, and on curves sometimes about the centre of each rail as well. Sole-plates are also occasionally used. Depth of ballast about 12in. below the underside of the sleeper, bottom ballast 6in. quarry shivers, top 6in. gravel or broken stone; gravel is probably the most suitable ballast for light railways, as broken stone makes a harsh and noisy road.

Details of Cost of Construction.

The most important item is usually for permanent way, and this, including fencing, is variously put down for a light railway at from £1,000 to £1,800 per mile. The rails, fishplates, bolts, etc., of course, vary with the market, but as regards the other items of permanent way, uncreosoted sleepers 9ft. by 9in. by 4½in., cost about 1s. 6d. each; laying permanent way, 1s. 6d. per lineal yard forward; ballast pitching and boxing, also 1s. 6d. per yard forward; sod fencing both sides, 9d. to 2s. per lineal yard; and wire fencing, 1s. per lineal yard. Clay cutting is probably the next most important item, and is frequently put down at 1s. a cubic yard for cutting, and 8d. for filling; sometimes cutting and filling are estimated together at 1s. 2d. to 1s. 8d. per cubic yard, and 1s. 2d. a yard will generally be found a very fair price for it. Rock is estimated at 1s. 6d. to 4s. a cubic yard, according to circumstances. Masonry work varies so much that it would be impossible to put an average price on it. Metalling and forming roads and level crossing, 1s. to 2s. per yard super. The above give some idea of the prices at which work is let to a contractor. The actual cost is, of course, in many cases far less. I have known clay, for instance, taken out and tipped at 4d. per cubic yard, and fencing sublet to a labourer at 1s. 6d. per Irish perch.

Rolling-Stock.—Engines, £500 to £1,800 each; coaches, £300 to £500; wagons, £50 to £150.

Objections, etc, to Tramways Running along the Sides of Public Roads.

When the condensation of the escape steam is properly effected, the machinery invisible and the sound from it inaudible, the danger of running a steam-engine along a public road is very much minimised; while, further, if ample room is left for the ordinary traffic, little objection can be raised to the construction of a tramway alongside it. A few minor objections, however, may be raised—for example, the duty of seeing that the line is constructed in a proper manner, and that it is fit to be opened for traffic lies with the Board of Trade, but the onus of seeing that public rights are not interfered with, and that the roadway is maintained safe for traffic, is left to the county surveyor. As, however, the contractor can frequently save a few pounds by taking in a little more of the roadway on one side instead of a strip of land on the other, and the engineer can obtain better gradients by dropping his line a little below the roadway in places, the county surveyor has to exercise constant supervision over the work. Once the contractor has got his line laid down it is very difficult to induce him or compel him to alter it. Another objection to these tramways is that they are frequently raised, to suit the gradients, 2ft. or 3ft. over the road level, and the occupiers of the fields inside the tramway are constantly endeavouring to cart across the line, and in order to do so have to make some sort of an approach on the public road to reach the tramway level, and so raise a dangerous obstruction to the road traffic.

Electrical Tramways.

Electrical tramways may be classified under five heads, according as (1) the conductor is an overhead wire; (2) is laid underground; (3) is a central rail laid on the surface; (4) is a side rail; or (5) when accumulators are used.

The overhead system, which may be subdivided into the span-wire system and the side-wire system, is doubtless the best known in Great Britain. Some of the objections raised to it are the unsightly appearance of the poles, the difficulties at sharp curves and where wires cross, and the possibility of the wires breaking. I understand, however, that the poles recently erected in connection with some continental systems are "things of beauty," and one objection to this system has therefore been got over; moreover, the difficulties with sharp curves and cross-wires have been very much minimised, while the danger of the

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wire breaking is little more than imaginary. This system will probably be found, as a rule, the most suitable for suburban and rural lines. The underground system will, no doubt, come more into favour for street tramways, but it is an expensive system: a slot of any sort in a street is objectionable, and the difficulty of keeping the tube free from dirt is an objection to it. For light railways or tramways laid on private land, or carried overhead or underground, the central rail is perhaps the simplest and cheapest, but the difficulties of arranging points and crossings, owing to the central rail, are considerable. In particular cases, as in the case of the Portrush and Causeway Tramway, the side rail answers well. The cost of the accumulator system renders it generally prohibitive. Two of the earliest electrical tramways constructed in the United Kingdom were the Portrush and Causeway Tramway, opened in 1883, and the Bessbrook and Newry Tramway, opened in 1885. Both of these tramways have been fully dealt with in papers read before the Institution of Civil Engineers, and it is therefore unnecessary for me to enter into many details regarding them. In both cases the electricity is generated by means of turbines worked by water power. The generating station in connection with the Portrush and Causeway Tramway is some seven miles from Portrush, the starting point of the tramway, while the generating station in connection with the Bessbrook and Newry Tram way is at Millvale, about half-way between Bessbrook and Newry. At both places the arrangements are so simple that only one attendant is required at each station to look after the whole of the machinery, etc.

Portrush and Causeway Tramway.—This line is eight miles in length and 3ft. gauge; the conductor is at the side and of T-iron, weighing 19lb. to the yard, placed about 2ft. 6in. above the level of the permanent way. Contact is maintained by means of brushes projecting from the sides of the cars, and the return circuit is conveyed through the tram rails. The cars are taken from the terminus of the Northern Counties Railway to the commencement of the electric tramway, a short distance out of Portrush, by means of ordinary locomotives.

Bessbrook and Newry Tramway.—This line runs from Newry to Bessbrook in County Armagh, a distance of 3 miles 2 chains. The gauge is 3ft., and the maximum gradient 1 in 50. The conductor consists of a central rail of channel section resting on insulators; at the joints the electrical connection is made by means of bent strips of copper riveted to the channel iron. Where the tramway crosses minor roads the conductor consists of a cable carried underneath the surface, and where the tramway crosses the main road from Armagh to Newry the conductor is carried overhead. The return circuit is through the tram rails, the rails being connected at the joints by wire or copper strips. The motors are of the Edison-Hopkinson type, and are placed on the front of the cars, and the gearing arrangement, although rather complicated, is working satisfactorily. No doubt the practice now being adopted on other lines of placing the armatures on the axles of the cars very much simplifies the working, but I imagine that it must be found difficult to keep the parts clean in such a position, and they are also more liable to suffer from vibration and inequalities in the road.

The rolling-stock consists of three passenger cars, two of which are provided with motors in front, and numerous wagons. The wagons are designed with flangeless wheels, so that they can be drawn by horses from the terminus in Newry to the quays, and these wheels run, not on the tram rails, but on rails placed immediately outside them and at a slightly lower level. Of course, the fact of there being four tram rails, as well as a central conductor, renders the arrangement of points and crossings extremely complicated, but otherwise no difficulty has been experienced in the working of the system. This tramway has now been open for traffic for the past 10 years, and it is satisfactory to note that the cost of working and general expenses have been extremely small.

Time will not permit the author to deal with horse tram ways in our larger towns in Ireland, and he trusts that some member with more experience of these tramways will present the association with a paper on a future occasion.

Conclusion.

The subject of light railways and tramways in this country is a large one, and the need for them is great. Government has dealt liberally with Ireland in the past, and it is to be hoped it will deal still more liberally in the future. Further free grants to the poorer districts, and the issue of loans of 2 or 3 per cent. on a grand jury guarantee in every district, would probably be the means of doubling the tramway system of Ireland in a few years. In order, however, to make the Irish tramway systems popular and useful, it is necessary that the rates charged for the conveyance of goods and passengers should be as low as possible. To enable this to be done, the working expenses must be reduced to a minimum. In this country—at any rate inland—coal is dear, but water is plentiful and can be rendered easily available for the working of turbines or other hydraulic machinery. The author therefore ventures to suggest that the motive power for the working of tramways in Ireland may possibly in the future be obtained most easily by electricity generated by means of hydraulic power, and he earnestly hopes that the close of the nineteenth century may witness the construction of light railways and tramways throughout the length and breadth of his native land.

CITY OF LONDONDERRY.

The following is Mr. J. Christie's report on the estimated cost of plant for the supply of private electric lighting:

Gentlemen,—At a meeting of the Lighting Committee held on June 20 last, I was instructed to report on the probable cost of a private lighting installation. I may mention that I have, during the past winter, drawn up a scheme which, to my mind, would best suit the requirements of this city, embodying all the necessary details of plant and alterations to the buildings, but as you now only wish the approximate cost of such a scheme, it is needless for me to enter into a detailed description of the system which I would propose to adopt until you really decide to go on with the work, so for the present I will confine myself to dealing with the subject chiefly from a financial point of view, and I now submit to you the result of my efforts in the following report. In the scheme which I would propose adopting, I would at first only lay down the supply mains in a limited area where the most probable demand for light and power exists, keeping in view, however, the extension of the system to outlying districts, chief among which is the Waterside. In this report I will deal mainly with the supply to the limited area, but will later on refer to the probable cost of such an extension. In the Waterside, the district consists largely of residences of the better class, many of which would be probable customers, and if a demand for 1,000 to 1,500 16-c.p. lamps could be depended on the extra sum necessary to lay down plant and mains to supply them should be self-supporting; but I may here mention that the return in these outlying districts per lamp connected, owing to the extra cost of distribution over such a scattered area, can never be so high as within the limited area. I would, therefore, consider it advisable to defer any extension outside the limited area until such time as the first instalment of plant had been worked up to a satisfactory basis; at the same time, when designing and laying down the plant, making such provision as shall allow of these extensions being carried out at a minimum of cost when the proper time arrives. The limited area where the supply would be first available would be as follows: along Strand-road and Foyle-street to bridge, up Carlisle-road, Ferryquay-street, Bishop-street, and Pump-street, along Butcher-street, Castle-street, and Richmond-street, down Shipquay-street, to Waterloo-place. Off these mains branches up side streets would be taken to suit customers as they sent in their applications. The first instalment of plant would be sufficient to run 3,500 16-c.p. lamps, or their equivalent, all alight at one time, allowing a suitable margin of spare plant as reserve. From past experience in other towns it has been found that rarely more than 75 per cent. of the lamps installed are ever alight at any one time, so that with this amount of plant we could with safety connect quite 25 per cent. more lamps than this number to our mains, or a total of, say, 4,500 16-c.p. lamps, so upon this number and the average price per lamp per annum, as obtained at other towns somewhat similarly situated, I will base my estimate of works' costs, probable revenue, etc. If a private supply scheme were gone on with, the additional staff, plant, and stores would all have to be run in conjunction with the existing public lighting system, and it would be a most difficult matter indeed to know where to draw the line when allocating the fair share of expenses to each department—

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the public and private lighting. The only way to overcome this difficulty would be for the Corporation to allow the electricity department for lighting the streets a certain fixed sum per lamp per annum, which we might look upon as revenue, paying all expenses connected with the public lighting by electricity out of this sum, and, if possible, make a small profit, which profit could be set aside as a sort of reserve fund, and used from time to time for extended the public lighting scheme, and gradually do away with the gas lamps. At present we have 170 arc lamps erected. In London and other large towns for similar lamps the supply companies or municipal stations are allowed by the corporations or vestries £26 to £30 per lamp per annum, but as we do not require to run our lamps for quite such long hours, I would say a fair price for this Corporation to allow the electricity department would be not less than £20. 10s. per lamp per year. This would work out at about £3,500 per annum. My estimate of the works cost (see report of December 20, 1894) was £2,300, to which must be added, say, £1,200 for repayment of loan, interest, etc., making a total of £3,500 for street-lighting by electricity. Owing to the increased economy and efficiency of boilers, staff, etc., due to the working of the public and private lighting schemes in conjunction, I reckon we will be able to reduce this sum by £300 a year. I think if such a result were attained it would only be fair to credit the department with this saving, utilising it in the manner I have already suggested. To put down the private supply plant of the capacity I propose, and do everything in first-class style, would necessitate an outlay of some £20,000, which would be made up as follows :

Buildings, including offices, house, etc.	£1,750
Boilders, pipes, etc.	2,750
Engine-room plant	6,400
Mains, etc.	7,500
Instruments, meters	600
Contingencies	1,000
	£20,000

To provide for the Waterside and outlying districts would necessitate a further expenditure of about £6,000. It would, therefore, be advisable to borrow £26,000, at first only spending the £20,000 on the limited area, and have the £6,000 in hand for future extensions, without having to call a second Local Government Board enquiry, when such extensions became necessary. An approximate balance-sheet of the undertaking, assuming all the lamps were taken up—and this could reasonably be expected within the second year of operation—would be as follows :

REVENUE.

Public Lighting.—170 arc lamps, at £20. 10s. per lamp per annum		£3,485
Private Lighting.—4,500 16-c.p. lamps, using 30 units per lamp per annum, at 5d. per unit =135,000 units		2,812
Guildhall Lighting.—Lighting hall and clock		110
		£6,407

EXPENDITURE.

Public Lighting.—172* arc lamps, including all costs, at, say, £18. 12s. 3d. per lamp per year... * Two extra lamps in station, testing, etc.				£3,200
Private Lighting.—Works costs, generating 135,000 units, at 2·47d. per unit, made up thus :				
Coal.....	·75d. per unit	£420	0 0	
Oils, etc....	·25d. ,, ...	140	12 0	
Wages.....	·97d. ,, ...	550	0 0	
Repairs ...	·50d. ,, ...	281	5 0	
	2·47d.	£1,392	17 0	
Proportion rates, taxes, etc.....		75	0 0	
Management and office expenses.....		250	0 0	
		£1,717	17 0, say	£1,720
Guildhall Lighting.—Expenses for clock and hall lighting				50
				£4,970
Income				£6,407
Outlay				4,970
Profit				£1,437
Less assumed profit on street-lighting				300
Profit				£1,137

after paying all works' costs. This sum, £1,137, represents a sum of 5·68 per cent. on the capital outlay out of which to pay interest, etc.

Gentlemen, I have not in any way tried to present this scheme to you in too prosperous a light, but have simply given you figures based on averages which have been actually obtained, and in many cases exceeded in other municipal electricity supply stations in this country, and there is no reason why Londonderry should not do equally well. The success of the undertaking is simply a question of demand, and, if every citizen having premises within the area of supply will only look upon the scheme as an enterprise in which he is indirectly a shareholder, and encourage it by contributing to its success by becoming a consumer, no matter how small a one, I have no hesitation in saying that these figures which I have given you will be more than realised, whilst the public will obtain a better and a more healthy light, and also a source of motive power, at a cost which certainly will not exceed the present price of gas, considering the many increased advantages of electricity.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Alexandria.—The municipal authorities of Alexandria, Egypt, invite applications by October 1, 1895, for the concession of the tramway lines from St. Catherine Place, through the outer boulevards, to the projected abattoirs at Mex, with a branch line. Security £E1,000.

Bedford.—The Urban Sanitary Authority invite tenders for the supply of vulcanised rubber cables, in accordance with the specification which can be obtained from Mr. T. S. Porter, clerk to the Authority, on payment of a fee of 5s. for each copy. Sealed tenders, endorsed "Electricity," to be delivered at his office not later than September 4.

Braila.—The Municipal Authorities of Braila, Roumania, invite tenders by October 2 for the construction and working of a system of electric tramways in the city. Provisional security, 10,000f. This contract was originally fixed for July 29. Tenders are further invited by the Municipal Authorities of Braila for the lighting of the city by electricity or by electricity and gas. Provisional security 10,000f.

Great Yarmouth.—Tenders are invited for the supply of coal to the electric light station for 10 months from September 10, for the Electric Lighting Committee. Specifications can be seen and forms of tender can be obtained at the office of Mr. J. W. Cockrill, borough surveyor. Tenders, on the form and in the envelope supplied, are to be delivered at the office of Mr. T. M. Baker, town clerk, before noon on September 3.

Chepping Wycombe (Bucks.).—The Urban Sanitary Authority for this borough are prepared to receive tenders from public companies for working the electric order obtained by them within the borough for a term of years and upon approved conditions. Tenders are to be delivered by noon on October 14 next, at the office of the town clerk, High Wycombe, where a copy of the electric order may be seen and further particulars obtained. The Authority do not bind themselves to accept any tender.

Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

Oldham.—The Baths Committee of the Oldham Corporation are prepared to receive tenders for supplying and fixing wires, fittings, etc., for lighting by electricity a portion of the Central Baths, Oldham. Specifications can be obtained from Mr. S. Willmott Newington, borough electrical engineer, Gas-street, Oldham, on payment of 10s. 6d., which will be refunded on the return of the specification, accompanied with a *bond fide* tender. Tenders, endorsed "Tender for Wiring," must be sent to the office of the town clerk, Town Hall, Oldham, before noon on September 11.

London, W.—The Hammersmith Vestry invite tenders for complete schemes for public and private lighting, and for the supply of motor power in that portion of the parish of Hammersmith described in the provisional order as the compulsory area. Memoranda of instructions, with a map of the district, may be obtained from Mr. H. Mair, surveyor to the Vestry, between the hours of nine and five, Saturdays nine and one, on payment of a deposit of £10, which will be returned to persons sending in a bona fide tender. Tenders are to be delivered at the meeting of the Vestry, at the Vestry Hall, at 6.30 p.m. on September 4.

Stafford.—The committee of the Staffordshire County Infirmary invite tenders for wiring and fitting the infirmary for electric light. Tenders, sealed and addressed to the secretary, Staffordshire County Infirmary, Stafford, and endorsed "Tender for Electric Lighting," must be received by him not later than noon on September 14. Copies of the specification, with form of tender attached, can be obtained from the secretary on payment of £1, which will be returned on receipt of a *bond fide* tender ; and plans may be seen on or after Monday, September 2, at the infirmary, or at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, London, S.W.

Sunderland.—The Corporation of Sunderland are prepared to receive tenders for the following : (*a*) high-tension and low-tension concentric cables ; (*b*) cast-iron pipes, and box frames and covers ; (*c*) stoneware casing, boxes, and bellmouth protectors ; (*d*) high-

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tension transformers for alternating current; (*e*) meters for alternating current. Specification, conditions of contract, and form of tender may be obtained on payment of £1. 1s. at the office of the borough electrical engineer, Electric Supply Station, Sunderland. The deposit will be refunded on receipt of the specification and conditions of contract with a *bonâ fide* tender. Sealed tenders, addressed to the chairman of the Highways Committee should be delivered at the town clerk's office by 6.30 p m on Friday, September 13.

Queenstown (Ireland).—Tenders are invited by the Queenstown Town Commissioners for the lighting of Queenstown by electricity (private as well as public) as per report and specification of Mr. R. Hammond, M.I.E.E., Ormond House, London. Tenders are also invited as follows: the contractor to provide the capital for the due erection of the works and maintenance thereof as per above plans and specifications, on being guaranteed the public lighting, and a stipulated number of private lights (to be agreed upon), the Commissioners having the right to purchase within a specified period. Plans and specifications are deposited at the Hall, Queenstown, and can be inspected there between 11 and 2. Tenders must be lodged with the town clerk, Queenstown, marked "Tender for Electric Lighting," by 2 p.m. on September 16. Further particulars and conditions to be had on application to Mr. James Ahern, town clerk, Queenstown.

RESULTS OF TENDERS.

Belfast.—The tender of Messrs. Wormald and Co. has been accepted by the Corporation for covering the exhaust-pipes of the engines at the electric light station.

COMPANIES' MEETINGS AND REPORTS.

NORTH STAFFORDSHIRE TRAMWAYS COMPANY.

The twenty-ninth ordinary general meeting of this Company was held on Tuesday at the Guildhall Tavern, Gresham-street, E.C., Mr. W. J. Carruthers-Wain, A.I C.E, presiding.

The Secretary (Mr. J. G. B. Elliot) having read the notice convening the meeting,

The **Chairman** said: With regard to the figures for the half-year, I may say we are not singular in not showing a good result. Our friends, the North Staffordshire Railway, are also suffering from a decreased dividend, and as an indication of the scarcity of trade in the district at the beginning of the year I may tell you that in the half-year they moved 170,000 less tons than in the corresponding half of last year. Then, again, they naturally, like ourselves, met with difficulties in carrying on traffic in the face of one of the most severe winters, I suppose, which has ever been experienced. Under such circumstances you cannot diminish your service—at least you ought not to. You must keep faith with the public so far as you can, and although your traffic receipts are very much smaller, your expenses are not only on the ordinary scale, but have to be kept up on an extraordinary scale, in order to keep your line working. Had we been dealing with ordinary conditions, the increased mileage would have brought you a very large additional amount of money with very little, if any, additional expense except that which is necessary owing to the increasing age of the line and the engines. The first duty of the directors must be to keep your line and rolling-stock in a first-class state of repair. If they did not endeavour to do that as far as possible they would have constant difficulties with the Board of Trade and the local authorities, and it is such difficulties that we are endeavouring to avoid, especially having regard to the fact that the seven years' steam license expired in May last, and naturally we desire its renewal, and have to take all necessary measures and precautions to ensure the continuance of your traffic. Well, that we have done, and, I believe, successfully. Respecting the distribution of the profit, I do not suppose anyone will object to that. With reference to the vexed question of Longton, which has been so frequently before these meetings, I am very pleased to tell you that as a result of the amount of light thrown upon the subject during the proceedings of the Light Railways Committee, of which, as president of the Tramways Institute, I was a member, the Board of Trade are likely to meet the Longton Town Council, and little differences will be smoothed over by judicious consideration on both sides The Longton lines will, I believe, before long, not only be allowed to be worked, but valuable extensions of them will be made by the Corporation at their own expense, and I hope, having regard to the good relations that exist between us and the Longton Corporation, that we shall be able to work those lines for your profit. That will be a great satisfaction to me, seeing that so much of your capital has lain dormant there for so many years—in fact, at one time it was looked upon as hopelessly lost. If no other good comes out of the Light Railways Committee, that, at any rate, will be something in your favour. Then I come to paragraph 6, which is perhaps the most important paragraph in the report. You can quite understand, speaking with all deference and all due respect to the constituted authorities, that they have naturally, and I am bound to say I do not think improperly, a desire when they have an opportunity to take advantage of it, at any rate to some extent. The expiration of our steam license in May last was an opportunity for them to say, "Now, although we are very well satisfied," and that is what they did say, "with the manner in which you conduct steam traffic, yet steam traffic is not likely to go on for ever. We want you to take into your most serious consideration the question of the adoption of some improved motor upon these lines." Naturally we said in reply that we are very well satisfied with steam as it is. Steam has afforded enormous convenience to the inhabitants of this and many other districts. In this district it has been worked with less complaint than in any other in the kingdom, and that it has been exceedingly well worked is testified by the fact that when the Tramways Institute of Great Britain and Ireland, which comprises some of the leading companies in the kingdom, visited Stoke-upon-Trent in April last, they expressed their unbounded satisfaction with the manner in which the steam tramway was conducted in the district. Be that as it may, a great many people consider that steam traction is a thing of the past, or will not long survive, and that other forms of traction must come to the front. Of course there is no doubt that, having regard to the severe gradients with which we have to contend in North Staffordshire, the only system which can possibly be adopted there would be either the cable or electricity by means of overhead wires. So far as the cable system is concerned, the traffic is not great enough for that, and the curves are tremendous. Therefore the difficulties of working a cable on a single road would be exceedingly great, and the expense would be tremendous. Consequently, the directors are forced to consider electricity by means of overhead wires. We, therefore, suggested to the Town Council that if they desired us to give up the use of steam and adopt electricity, they should give us an extension of our lease in order to give us time to recoup ourselves for laying down such an installation. We pointed out that it was perfectly impossible that in the seven years or thereabouts that remained to the Company now of the original 21 years for which that obsolete and, I might say, absolutely stupid Act of Parliament, known as the Tramways Act, 1870, granted the company powers, it would be impossible for anyone to advance money or undertake to work a line for a limited time like that. I am happy to say that the local authorities agree that if we do put up an installation of this character they are prepared to extend our lease for a considerable period; or, rather, to put it in a more technical way, they are prepared not to exercise their powers to purchase under Section 43 of the Tramways Act, 1870, for a very much longer period than we at present enjoy. I may be wrong, but I think that this is the best way in which to go to work with local authorities. They want something from you, and you naturally ask something from them, and if you can agree upon the principle I do not think there will be very much difficulty about the details When a proper scheme is matured for the working of the line by electricity, and when all necessary preliminary arrangements have been made by the local authority, and before anything is done which will commit you absolutely, you will be called together, and the fullest details will be laid before you, and your approval will be asked to any agreements which we propose to enter into. Whatever further steps are taken with regard to the extensions, before anything is done which would commit you in any way to them financially, or even in the improvement of the permanent way, your opinion will be asked, and you will be, as you always have been, taken into our fullest confidence, so that we shall be able to know that in what we are doing we have the assurance of your fullest support. Before I sit down, I would like to say one word on a personal matter to which I will only allude in the briefest possible terms. There are men whose position sometimes even in a small way marks them out for personal attack. I allude to this simply because some attacks sometimes find their way into newspapers circulating in the locality which this line serves To honest criticism from intelligent critics no one can possibly object. On the contrary, well directed, intelligent criticism is very useful; but I consider contemptuously the captious, cavilling criticisms and the scandalous scurrility of people whose insolent ignorance is only equalled by their malicious mendacity. I beg to move the adoption of the report and accounts.

Alderman E. J. Hammersley, J.P., seconded the motion, which was carried after some discussion.

A dividend at the rate of 6 per cent. per annum on the preference shares, and 3 per cent. per annum on the ordinary capital for the half-year was declared, and a cordial vote of thanks was passed to the chairman, directors, secretary, manager, and staff.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY, LIMITED.

The fifth ordinary meeting of this Company was held on Monday at the Cannon-street Hotel, E C.

Mr. W. S. Schuster moved the adoption of the report, which, he said, covered a period of two years' working, although the present directors had only had the management for six weeks. He stated that the contract made with the Electric Construction Company before the present Board came into power they had repudiated entirely, on the ground that it was so one-sided that no court would uphold it. Certain persons wanted the Company wiped out, but the present directors had resisted these attempts, and up to the present date the court had supported the directors' action.

The report was adopted.

Hermite Process of Sanitation.—The War Office have instructed Messrs. Paterson and Cooper to proceed with the erection at Netley Hospital of the Hermite sanitation plant, the cost of which has been provided for in this year's parliamentary estimates. The Corporation of Cape Town have also ordered a plant for producing electrolysed sea-water with a view to the Hermite process being applied to the sanitation of the place.

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BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2 945.

Bromley.—The Urban District Council have held a meeting at which, in answer to Mr. Peill, the Chairman replied that the Council was in communication with the syndicate which proposed to buy up the Council's powers under the provisional order for electric lighting.

Pneumatic (Self-Closing) Tube Company, Limited.—This Company has been registered by Jordan and Sons, Limited, 120, Chancery-lane, W.C., with a capital of £50,000. to carry on business as manufacturers of and dealers in indiarubber and other like gums, also as factors, merchants, etc

Partnership.—Messrs. Percy H. Tewson and Roland H. Streatfeild, A I.E.E., who were formerly with Messrs Laing, Wharton, and Down, have entered into partnership as electrical engineers and contractors, and will trade under the name of Tewson and Streatfeild, at 35, Bucklersbury, London, E.C.

Chloride Electrical Storage Syndicate.—We have received a copy of the third edition of the catalogue, issued in handy pocket-book form, which is published by the Chloride Electrical Storage Syndicate, Limited, of Clifton Junction, Manchester, and 16, Victoria street, Westminster, at the price of 1s.

International Cable Company.—By order of Mr. Justice Stirling, a final dividend on the shares in the International Cable Company, Limited, at the rate of 5s. 3¾d. per share, will be paid at the offices of Mr. F. S. Lucey, the official liquidator, 15, George-street, Mansion House, on and after Monday, 26th inst.

Gilmorton (Leicester).—At the Parish Council's last meeting the clerk read correspondence with the Postmaster-General as to a telegraph office in the village, and the guarantee required. As it was a matter which concerned other parishes, the Council decided that the matter should be left to private enterprise.

City and South London Railway.—The returns for the week ended August 25 were £875, compared with £878 for the corresponding period of 1894, being a decrease of £3. The total receipts for the half-year 1895 are £6,883, as compared with £6,941 for the corresponding period of 1894, being a decrease of £58.

Coalville.—At the last meeting of the Urban District Council the clerk read a communication from the Local Government Board asking for guarantors for the increased postal facilities at the post office at Ratby. As there was no mention in the letter of telegraphic facilities, which had been applied for, the Council instructed the clerk to write to the Department enquiring why no reference was made to the application for increased telegraphic facilities.

The Tudor Accumulators.—Mr. A B Pescatore, of Haworth's-buildings, 5, Cross street, Manchester, informs us that he has acquired from Mr. Tudor the sole concession for the United Kingdom of his system of accumulators, and that he has established works for their manufacture at Dukinfield, near Manchester. It is stated that more than 5,000 batteries of Tudor accumulators are working in different parts of the world; among which 60 have an output exceeding 150 h.p., and several an output exceeding 500 h.p.

Loughborough.—At the last meeting of the Town Council a letter was received from the Local Government Board with reference to the Island House Park loan. The sub-committee reported that as land would shortly be required for an electric lighting station and other public works, it would be folly to sell any portion of the area as surplus land, with the certainty that other land would have to be purchased in the near future in a less convenient position, and possibly at a larger price, and that until the whole area was thus occupied the part not otherwise utilised would be used as a pleasure ground.

Llandudno.—At the last meeting of the District Council a letter was read from the secretary to the Llandudno Electric Supply Company, Limited, referring to the order which the Council have recently obtained for the supply of electricity within their district, and enquiring whether the Council propose to carry out the work themselves or whether they would feel disposed to allow it to be done by his company, and if the latter course be preferred, on what terms. It was decided that the question be referred for consideration to a committee consisting of the chairman of each standing committee.

Llanelly.—A meeting of the Llanelly Chamber of Commerce has been held, at which it was stated that electric lighting was a question which has agitated the mind of the public and the Borough Council of Llanelly for several years, and the action of the Llanelly authority during the past year impressed the Council that an address by an expert would be instructive. Mr. J. C. Howell, electrical engineer, a member of the Chamber, and a gentleman thoroughly qualified to speak on the subject, was accordingly invited to read a paper. He cordially responded, and delivered a valuable and interesting address on the subject of "Electrical Energy."

Leamington.—At the monthly meeting of the School Board a letter was read from the Midland Electric Light and Power Company, stating that they proposed to run a cable for the supply of electric light along a portion of Dormer-place at their own expense if they found that the demand was sufficient to justify them in so doing. They would therefore be glad to know if the Board would adopt the light in their offices. The charge was 8d. per unit. Mr. Barrett moved that the clerk be empowered to obtain an estimate, and that it be submitted for consideration at the next meeting of the Board. After discussion the motion was carried *nem. con.*

Situations Vacant.—An engine and dynamo man, accustomed to the work in an alternating-current station, is required. Preference will be given to one who has served his time as a fitter. Wages £1. 12s. per week. Apply in writing to the town clerk, Southport.—A large West end firm require a very competent man to take entire charge of a City branch. Must be thoroughly well up in gas and electric lighting, heating by gas, water, and steam, and ventilation work. Only those need apply who have had good experience in above branches of work One who has been employed in the City preferred. State references and salary expected to Box 1021, Sell's Advertising Offices, London, E C.

The Telephone Service.—At the monthly meeting of the Council of the Halifax Chamber of Commerce the report of the General Purposes Committee on telephones was read. It stated that out of 211 circulars sent out as to the telephone service 70 replies had been received. All were unanimous in saying that the present charges were too high, and suggesting £5 as a more satisfactory charge. The complaints as to inattention were numerous. In many cases communication with other towns was delayed sometimes as long as 40 minutes. Several suggested that the annual rental should include all trunk charges, especially to the neighbouring towns. It was decided that along with Dewsbury and other Chambers who were taking this subject up that the utmost be done to remedy these grievances.

Westfield.—Councillor Tuppenney, J P., is taking active steps to procure telegraphic communication for Westfield. He has addressed a letter to the Parish Council, in which he says: "At the last meeting of the Battle District Council an application was made by the Post Office authorities for permission to place poles by the roadside from Doleham railway bridge *en route* to Brede, to carry a telegraph line from Hastings to the former place The application was of course, granted as far as the Council have jurisdiction. I beg to call your attention to the fact, hoping that you will place the matter before the Parish Council with a view to a representation being made to the Postmaster-General that, as the line will be within a comparatively short distance of our own post office, telegraphic communication could at a small cost be conferred upon Westfield."

Birkdale.—At the last meeting of the District Council attention was directed to an application, which had been referred to the law clerk, that was made by Mr. Buckley, of 6, Westcliffe-road, to allow him, in case the Southport Corporation brought the electric light to the Birkdale boundary, to put a small private cable from the Corporation cable to his house. Mr. Buckley added, in his application, that he would, of course, move the same whenever the electric light was adopted by the Birkdale District Council. The Law Clerk said the matter was one which required very serious consideration. He could not tell when the electric light would be adopted in Birkdale, and there were matters concerned with the rebate on the gas and other things to be considered. It was not a matter entirely for him; it was more for the committee to make their own terms, and he could then draw up an agreement. Mr. Buckley would very likely not agree to it, and at any rate he should want the help of the committee.

Bath.—"With reference to the 'partial failure' of the electric light, which led to a debate at the Surveying Committee," states a note writer in the *Bath Chronicle*, "I am told by Mr. Metzger, the company's manager, that the matter is easily explained. It seems that the contract for the supply of carbons having run out, the company were anxious that the illuminating power of the new carbons should be such as to satisfy the committee, and to this end five different kinds of carbons were tested in the street lamps all the lamps being trimmed alike to obtain a fair result under the proper conditions, and Mr. Gatehouse was asked to report on their qualities. These tests had been made for a fortnight previously, but unfortunately the quality of the carbons used on Saturday and Sunday last was below the standard, although their price is the highest of all. It will be seen, therefore, that the company acted with the best intentions, and purely with a view to obtaining the best possible light."

Kingswood.—A meeting of the Urban Council has been held, at which a long letter was received from the firm who have taken over the electric lighting of Kingswood from Messrs. Parffitt advising several alterations and private lighting under the Council's contract. The Chairman said that it was a matter which called for very careful handling. Of course, there would be objections raised to any alterations of the present contract, and they were in the dark as to the details. They could not have private house electric lighting very well from the overhead wires, and therefore he advised that a small committee should be appointed to investigate the matter. Members might have observed, he said, that the light was very good on the previous night on the occasion of the flower show. Mr. Weight remarked that this only showed that a stronger light could be put on if the company wished. The chairman, vice-chairman (Mr. A. J. Bridges) and Messrs W. T. Howes, S. Burchill, and A. J. Evans were selected as a committee.

Dover.—A meeting of the Town Council has been held at which a letter was read from the electric light company, referring to the statement of Councillor G. Mowll at the previous Council meeting to the effect that the lamps in King-street and Bench-street were placed in the worst possible positions, and pointing out that the responsibility of the position did not rest with them, as the sites were chosen by the late surveyor very much against the advice of their officials. Councillor G. Mowll complained that the company

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had not made this application before. The late surveyor had, in answer to a question put by himself, denied having anything to do with fixing the lamps. Alderman Adcock suggested that the lamps should be altered. As the late surveyor had fixed the present position, the Council would have to bear the cost. He moved that the matter should be referred to the Town Ward Lighting Committee. The motion was carried. A local paper states that it understands that negotiations are in progress between the Harbour Board and the electric light company for the supply of electric current to obtain power for driving cranes on the Admiralty Pier to transfer baggage to the boats. The necessity for a more rapid transference of the luggage is being at length recognised by the Harbour Board, but whether the cranes will be worked by electricity or not they will certainly be erected.

Brussels.—The report on the electric and gas lighting of the city has just been presented to the Municipality, and it is stated that the sales of gas for lighting amounted to 639,935,000 cubic feet, a decrease of 17½ millions, which was exactly what had been anticipated from the supply of electric light from the municipal electric lighting works. The station, the construction of which was resolved upon in 1892 at a cost not to exceed £100,000, was started on November 3, 1893. The station had three boilers of 2,500 square feet heating area, two 500-h.p. engines, four dynamos of 143 units, and a battery of accumulators of 140 cells to give a current of 350 amperes for 10 hours. As it was obvious that another engine would be required, one of 500 h.p. was ordered in October, 1894, and put in in February, 1895. Another station is in course of construction, a smaller one, for a local demand. At December 31, 1894, the capital outlay had been £87,873. The works are being run in the meantime by the India Rubber, etc., Company on the town's account. The cost of production, distribution, and public lighting was £3,347, and the receipts £5,862, leaving a gross profit of £2,515. This corresponds to 2·86 per cent. on the capital outlay at December 31, 1894; or, not taking the gratuitous supply for municipal lighting into account, 3·64 per cent. The Board of Trade unit cost 3 36d. The mains laid were 8¾ miles, and the feeders 11,900 yards. Number of 16-c.p. lamps, 11,655. The maximum output, on December 22, was 2,115 amperes, corresponding to 4,200 lamps, or 36 per cent of the lamps put up. The average price paid for current was 7·92d. per Board of Trade unit. The price was at first 9 6d., but was reduced to 7·68d. on August 6 last. The current used by the Hotel de la Ville and the King's House is charged at 4·8d. The public lighting comprises the lighting of the Grand Place by two lamps of 20 amperes, and the lighting of the Park in summer by 32 lamps of 12 amperes and two of eight amperes.

Blackpool.—With respect to the electric lighting extensions, the *Blackpool Gazette* says: "In view of the difficulty which we are assured has been experienced in fulfilling all the demands for current, the proposal to extend the electric lighting works does not come as a surprise. But we were certainly not prepared for an extension which will increase the capital account of the works half as much again as it stands at present. It appears at their meeting the Electric Lighting Committee decided to recommend an addition to the buildings, so that two new boilers and a couple of new engines may be erected. As this little order is to cost no less than £30,000, it is interesting to learn that the output of electricity will be thus increased by 300 kilowatts. If the working of the electricity department were satisfactory, we should not demur for one moment. In the ethics of sound business enterprise, an increased trade is synonymous with increased profits. But as we have repeatedly pointed out, there is excellent reason for doubting that the department is even paying its own way; and in this case it looks like increasing the outlay to fritter away more quickly the money of the ratepayers. Anyhow, the recommendation will give the chairman of the committee an opportunity of clearing up some of the points we have latterly raised, and we hope any explanation he cares to give will have particular bearing upon the present system of management." "Nemo," writing to the same journal, says: "It is reported that the Electric Lighting Committee has recommended that another small sum of £30,000 be spent in extensions to the works for next season. Is it necessary to spend so much more? I say most decidedly, 'No.' We have in the shed at the present time five boilers, of which three are 28ft. long by 7ft. diameter. The other two, I am told, are larger boilers. These are tested to work at 140lb. per square inch, and they work at the present time at 120. Each of these boilers will drive 500 i.h.p., which gives us a boiler power of 2,500 i.h.p. Now we are told that it is necessary to put in two more boilers. Coming to the engines, we find that in 1893, when the works started, the engines were stated to be one engine of 200 i.h.p, two engines of 100 i.h.p. each, and three engines of 60 i.h.p. each. About 12 months since another of 400 i.h.p. was put in, making a total of 980 i.h.p. This is how we stand at present: one shed, 150ft. by 50ft, containing seven engines, to get a kilowatt capacity of 440. This could be got with three engines and three boilers, and one-half the space occupied at the present time."

The Mersey Railway.—Mr. Charles Rettie, in a letter to the *Journal of Commerce*, says: "I read the other day the account of the Mersey Railway Company's half-yearly meeting, and perhaps you will allow me to refer to it, especially as I am interested in the "rapid transit problem" as applied to our great centres of industry and commerce. The Mersey tunnel has been a great boon to Birkenhead and Liverpool, and has opened up the Wirral district of Cheshire so that people can get to their places of business much more quickly than before. A very good point was raised at the recent meeting about the fares. It is very widely known that in almost every town in Canada and the United States they have a universal fare of five cents any distance on all the tramways and elevated railways, and not only that, in many places, such as Montreal, they have transfer tickets—that is, you could go from the Dingle to West Derby, changing at Lime-street, for 2½d. We have a good example of this universal rate here in connection with the penny 'buses running from the Pierhead to Prince's-road. On the average, there are 27 'buses running each day, nine of which are Mason's, and they carry between them an average of 9,720 each day, not counting the number of passengers the trams carry on the same route. My argument is this, if they can run the cars in America at a big profit, where the working expenses are far greater than in this country, and not only that, but first cost is greater, wages higher, and smaller populations than we have, surely we can run the cars in this country, where everything is so cheap, and charge a universal fare of 1d. any distance. The population of New York is about two millions, that of London five millions, yet the New York elevated railway carries three times the number that the Metropolitan Underground Railway carries, and pays twice as much. The Mersey Tunnel, I will admit, has had innumerable difficulties to overcome, and very heavy working expenses to meet, but the directors will not get their money back by a policy of big fares. I consider the chairman's remarks on electricity very unfair, amusing, and uncalled for. I do not know who the electrical experts were. The chairman only has to open his eyes and see for himself, without experts, the revolution electricity is working in railroading, especially as applied to local railways, not only as regards light railways, but on heavy roads where the heaviest rails are used all over the world. The steam locomotive, when compared with the electric locomotive, has not a leg to stand on; whether for express work for long distances, or for pulling a heavy train up a steep gradient, the electric locomotive is the best. It is a well-known fact that a locomotive burns about twice as much coal as a stationary engine similar to what is used in our large mills, and that is the reason that electricity has the pull over steam for traction purposes. By means of large, highly economical engines and boilers, with the aid of mechanical stokers, etc., and then transforming the power into electricity by means of dynamos, losing about 10 per cent. in the transmitting or converting of the power, and then transferring the current to the rails, which is picked up by the cars as they run along, losing a little more power in the transmitting of the current, but not sufficient to take any notice of—this is the reason that electric locomotives are more economical than steam locomotives. Another advantage of the electric locomotive is that it can go up a grade better; it has the same power on a hill as on the level, but not so with steam locomotives, as they lose all their power on a hill, when it is most wanted. Another important advantage is there is no smoke or smell, and as no fire or draught is required for the electric locomotive it can be boxed in, so they can run at a great speed without any risk to the driver, one of the principal drawbacks to the racing on the East Coast. Another advantage is that it takes less labour to run on an electric line, as everything runs so smoothly with very little manipulation, and does not require skilled labour to run the cars."

The Projected Derby-Ashbourne Electric Railway.—A large number of influential landowners and others in Derbyshire who have long been impressed with the great necessity for improved railway communication between Derby and Ashbourne manifest great inrerest in the proposed construction of a light (electric) railway between those towns. Mr. John Shaw, jun., of Derby (with the assistance of Messrs. Dickinson, of Birmingham, engineers, well known in equipping and working the South Staffordshire Electric Railway), has produced a scheme for the construction of this light railway, and the proposal has already met with much favour alike from the landowners, farmers, and others in the district. The question of better railway accommodation and communication between the towns of Derby and Ashbourne, and also the opening up of the districts lying between the two towns has long been discussed, and various schemes for a railway have been proposed, but they have all been abandoned on the ground of the initial cost, and, consequently, the improbability of the undertaking paying any interest as a commercial speculation. The prime cost of the railway equipped in the ordinary way was estimated at from £30,000 to £50,000 per mile. Consequently such a railway running from Derby to Ashbourne would cost from £600,000 to £800,000, whereas to build and work a light (electric) railway on the proposed overhead electric system, had been amply proved to be the cheapest and most suitable in the case of the Derby and Ashbourne line. The cost of running per car mile by the overhead system, including all expenses, with the exception of guard's wages and maintenance of permanent way, is 4·06d., as against 8·57d. by steam. It is proposed that the line should be connected with the existing Derby tramway, which terminates on the Ashbourne-road, and thence it would run through the parishes of Mackworth, Kirk Langley, Brailsford, Ednaston, Osmaston, Compton, into the town of Ashbourne, terminating near Compton Bridge. On only one portion of the proposed line is there really a stiff grade, and that is for about one mile at the Ashbourne end, but there will be experienced no difficulty in getting over this. It is suggested that the line should be laid on the western side of the high road, through nearly the whole length, as there is ample room, but through the villages it would probably have to run down the centre of the roadway. The permanent way would be laid at a cost of about £1,000 per mile. Paving would only be laid where absolutely required by the authorities, and in all probability it would only be insisted upon through the villages and a small portion at each end of the line in Derby and at Ashbourne. Electric signalling would be adopted to enable the crossings to be

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placed at as great a distance as possible from one another. Turn-outs and fixed stopping places will be made where necessary, but a car could stop anywhere to take up or to set down passengers. If the cars on the proposed railway are run at a maximum speed of 15 miles per hour the journey could be completed in an hour, thus showing a saving of time between the light railway and the ordinary railway on the North Stafford line. The rolling-stock necessary for a line of this kind consists of motor cars, trailers, and goods cars. A motor car would have to be equipped with motors of 20 e.h p. each. These cars would cost about £600 each, and trailing cars, which would only be used in summer, would cost about £200 each, while the goods cars, specially fitted, would cost about £100 each All the cars would be lighted by electricity, and the gross rough estimate, showing the entire cost of the line, cost of permanent way, including cost of materials, laying, etc., is estimated at £62,300 It is difficult, of course, to estimate what the traffic on such a line would amount to, but some years ago when a line was projected and surveyed between Derby and Ashbourne, the number of passengers arrived at was about 100,000 per annum. Mr Shaw in his scheme points out that if this number of persons could be carried for the low sum of 1s. 6d. per head (return fare)it would give a revenue of £7,500 per annum for passenger traffic alone. With regard to goods traffic, Mr. Shaw next points out that it would enable farmers in this important agricultural district to attend markets more frequently, besides enabling them to send in their milk and dairy produce at reasonable rates and without the laborious road journey which at present occupies a whole day. This scheme of light railway between Derby and Ashbourne has already received the sanction of a large public meeting of landowners and others, and a representative committee has been formed. It is the unanimous opinion in Ashbourne and the district that the light railway will be an unqualified success, and that it will tend to improve somewhat the agricultural drawbacks of that particular neighbourhood.

PROVISIONAL PATENTS, 1895.

AUGUST 19.

15529. **Improvements in electrical time-switches.** Arthur John Wheatley, 8, Highstreet, Harborne, near Birmingham.

15547. **An improved method of operating electric locomotives, tramcars, and the like, and apparatus therefor.** John Augustine Kingdon, 29, Marlborough-hill, St. John's Wood, London.

15563. **Improvements in the formation of electrodes for use in primary and secondary batteries.** Ludwig Epstein, 28, Southampton-buildings, Chancery-lane, London.

15564. **An improvement in electro propulsion of vehicles or vessels.** Ludwig Epstein, 28, Southampton-buildings, Chancery-lane, London.

AUGUST 20.

15664. **Improvements in electrical apparatus for railway signals actuated by passing trains.** Siemens Bros. and Co , Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.)

15686. **Improvements in electric railways.** William Phillips Thompson, 6, Lord-street, Liverpool. (James Francis McLaughlin, United States.) (Complete specification.)

15695. **Improvements in electrically-propelled carriages.** Ernest John Clubbe and Alfred William Southey, 53, Chancery-lane, London.

15703. **Improvements in electric cables.** George Gatton Melhuish Hardingham, 191, Fleet-street, London. (The firm of Felten and Guilleaume, Germany.)

AUGUST 21.

15722. **Improvements in the formation of thin plates intended to be subsequently assembled as in certain electrical and like constructions.** Walter Thomson and William Routledge, 3, St. Nicholas-buildings, Newcastle-on-Tyne.

15736. **Improvements in insulating wire for electrical purposes.** Walter Patterson, 218, Goswell-road, London.

AUGUST 22.

15787. **An improved electric connecting device applicable to electroliers, electric light standards, brackets, and the like.** Robert Walter Braham, 60, Red Lion-street, Clerkenwell, London.

15826. **Improvements in the insulation of electric cables.** George Gatton Melhuish Hardingham, 191, Fleet-street, London. (The firm of Felten and Guilleaume, Germany.)

15827. **An improved arrangement of apparatus for the generation of electricity on railway carriages or trains for lighting or other purposes.** Basil Rebikoff, 47, Lincoln's-inn-fields, London.

AUGUST 23.

15863. **Improvements in dynamo-electric or electro-dynamic machines.** John Grice Statter, 68, Victoria-street, Westminster.

15868. **Improvements in arc lamps.** Joseph Devonport Finney Andrews, 45, Fulham Park-gardens, London.

15870. **Improvements in and relating to electrically-controlled weighing-apparatus.** Lorenzo Howard Nutting, 77, Chancery-lane, London. (Complete specification.)

15880. **Improvements in electric accumulators.** Ernst Waldemar Jungner, 18, Buckingham-street, Strand, London.

15886. **Improvements in or connected with electric batteries.** Charlton James Wollaston, 4, South-street, Finsbury, London. (Complete specification.)

15889. **Improvements in the construction and working of electric arc lamps.** La Société les Fils d'Adolphe Mougin, 191, Fleet-street, London. [Date applied for under Patents, etc., Act, 1883, Sec. 103, 11th February, 1895, being date of application in France.]

15895. **Improvements in electric contact making and breaking apparatus.** Samuel Quincey and John Hoar Collins, 46, Lincoln's-inn-fields, London.

AUGUST 24.

15899. **Improvements in the construction of telephone instruments.** Thomas Frederick John Truss, 6, Pickering-road, New Brighton, Cheshire.

15952. **Improvements in or appertaining to electric lighting apparatus.** William Phillips Thompson, 6, Lord-street, Liverpool. (Wilhelm Kaiser, Austria.)

15969. **Improvements in incandescent lamps.** Peter Stiens, 24, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1894.

8607. **Electrical exchanges.** Thompson. (Keith.)

15004. **Telephonic installations.** Ritter.

17130. **Electrically heating liquids.** Stotz and Schindler-Jenny.

17774. **Electrical signalling apparatus.** Phonophore Company, Limited, and Smith.

18661. **Electric fuseholder.** Acme and Immisch Electric Works, Limited, and Moy.

18662. **Electric switches.** Acme and Immisch Electric Works, Limited, and Moy.

1895.

7458. **Electrolysis of metallic salts.** Kellner.

10445. **Electrolysis of alkali salts.** Störmer.

12161. **Electric conductors.** Moulart.

12468. **Electric railways** Müller.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¼-5⅜
Brush Company, Ordinary	3	2-2¼
—— Nom. Cum., 6 per cent. Pref.	2	2-2¼
—— 4½ per cent. Debenture Stock	100	113-116
Charing Cross and Strand	5	5¼-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	—	6¾-7¼
City of London, Ordinary	10	14½-15½
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	131-134
City and South London Railway, Consolidated Ordinary	100	38-40
—— 4 per cent. Debenture Stock	100	134-136
—— 5 per cent. Pref. Shares	10	14½-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1-2
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A 1-200 of £50	100	—
Electric Construction, Limited	2	⅞-1
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	2-2⅛
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	¾-1⅛
Fowler-Waring Cables	5	2-2⅜
W. T. Henley's Telegraph Works, Ordinary	10	11-11½
—— 7 per cent. Preference	10	15-15½
—— 4½ per cent. Debentures	100	106-109
House-to-House Company, Ordinary	5	3½-4
—— 7 per cent. Preference	5	7⅛-7½
India Rubber and Gutta Percha Works	10	19-21
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅞-8⅛
—— Pref.	—	—
Liverpool Overhead Railway	10	10⅞-11
—— 5 per cent. Pref.	10	15-15½
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	½-¾
Metropolitan Electric Supply	10	11-11½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-119
National Telephone, Ordinary	5	5⅞-6⅛
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	106-108
Notting Hill Company	10	8½-9
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7¼-7⅝
—— £4½ shares	4½	6-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8⅛-8⅜
—— 7 per cent. Pref.	5	9-10
Swan United Ordinary	3	2-2½
—— 4½ per cent. Debentures	100	104-107
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4⅛-4⅜
Westminster Electric Supply, Ordinary	5	8½-9
Yorkshire House-to-House	5	5¼-5⅜

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NOTES.

"**Harnessing Niagara**" is the title of an article in the current number of *Blackwood* by Prof. G. Forbes.

The Telegraph in South Africa.—Palapye and Belingwe and district are to be connected by telegraph with Buluwayo. Telegraphic communication between Umtali and Fontesvilla was established on July 21.

Books, etc., Received.—"The Universal Directory of Railway Officials, 1895," the Directory Publishing Company, of 8, Catherine-street, W.C. (10s); "Railway Wall Map of England and Wales," W. and A. K. Johnston, White Hart-street, E.C.

Proposed Paris and Rome Telephone.—The French Government, a Dalziel telegram says, is again opening negotiations with the Italian Government for the establishment of telephonic communication between Paris and Rome, *vid* Milan and Florence.

The Telephone in the House.—Telephonic communication between the Colonial Office and the House of Commons has been for some time in existence, but an instrument has now been placed in the Secretary of State's department, so that Mr. Chamberlain and his secretaries can at any time communicate with each other.

The Electric Light in India.—Calcutta has at last, a correspondent says, had the way made clear for the introduction of electricity for lighting and other purposes, for the legislative Act, which has been before the public for some months past, has now become law, and it is open to enterprising persons to put forward their projects.

The Stock Exchange and the Electric Light.—The *Financial Times* remarks that the settlement just completed has been quite as heavy as any that have gone before, the City being quite brilliantly illuminated all Wednesday night. The gas and electric lighting companies, the paper adds, must have reaped a rich harvest in the City this year.

Electric Cranes at Dover.—The Dover Harbour Board have decided to further improve the arrangements for landing and embarking at the Admiralty Pier by the construction of electrical cranes for the transference of passengers' luggage between vessels and trains. This, it is said, will often save 20 minutes or more in the despatch of the mail steamers.

Darkness!—Who will credit it at the end of the nineteenth century? A largely-attended meeting of the inhabitants of Clewer Without, almost at the gates of Windsor Castle, has refused to adopt the Lighting Act, and the parish is consequently to remain in darkness. A wag suggests that this "black spot on the Thames" should henceforward be known as Clewer-without-light.

An Important Telephone Suit.—Papers have been served on the National Telephone Manufacturing Company, at Boston, on behalf of the American Bell Telephone Company, of Boston, in a suit for an order restraining the latter firm from infringing the Berliner patent. It is said that the case will test the validity of the Berliner patent, and will be fought by the National Company with the assistance of several other telephone corporations.

Electricity in South America.—A correspondent writes that the telephone lines to La Plata have reached such a state of deterioration that conversation between Buenos Ayres and La Plata is virtually impossible; and that the proposed metropolitan railway for Monte Video is being strongly opposed in the Chambers, on the ground that the "viaducts, after the manner of the New York Elevated Railroad, would be very prejudicial to the inhabitants of the neighbourhoods which they crossed."

Light Comparisons.—The well-known German Prof. Wedding ranks the different methods of lighting in the following order, considering only the cost: incandescent gaslight, incandescent alcohol light, petroleum, Argand burner, electric incandescent light, and acetylene. He adds that the arc light is ahead of all the others, that the cost is the same as that of the incandescent gaslight, and that it is decidedly the best light for outdoor purposes.

Electric Headlights.—Electric lights will soon succeed oil-lamps as headlights on all the passenger-train locomotives of the Southern Pacific Company. This company has been experimenting with electric headlights for some time, and has at last, it is stated, perfected a light that can be operated by a dynamo on the engine, which will illuminate the track for a distance of 2,000ft. ahead. The Southern Pacific will be the first railway company in the United States to equip all its passenger-train locomotives with electric headlights.

Tunbridge Wells Electrical Exhibition.—An electrical exhibition will be held in Tunbridge Wells early in October, either at the Great Hall or the Town Hall, and there will be a formal switching on of the light by Lady Salomons. It is stated that applications for private lighting are coming in very rapidly and that there are now no fewer than 3,000, and the mains are about to be extended. Some additional arc lamps are, moreover, to be set up in the main thoroughfares, and in future the street-lighting will be continued on Sunday evenings.

The Latest London Railway Scheme.—It is stated that the construction of an overhead railway from Waterloo Station to Cannon-street Station is projected, that all the necessary surveys have been made, and that the Bill authorising the undertaking will be promoted in the next session of Parliament by the South-Eastern Railway Company. The new line would compete with the underground electric system now being built, but we are semi-officially informed that the promoters of the scheme are not very sanguine as to the ultimate consummation of their project.

Electrical Interference.—In the discussion on a paper read before the Chicago Convention of the North-Western Electrical Association, Mr. A. V. Abbott stated that there have been cases of continuous-current lighting in Germany "in which the establishment of a neighbouring alternating current actually put the lamps out—that is to say, interfered to such an extent that the lighting could not be carried on. By the introduction of appropriate impedance coils the trouble was practically cured. The method of transposition accomplishes the same result, but cannot always be employed."

The Anglo-French Telephone Charges.—Replying to Mr. B. L. Cohen, in the House of Commons, Mr. Hanbury has repeated his statement of the 27th ult., that the charge for the use of the London-Paris telephone was the subject of international agreement, and could not be altered without the concurrence of the Government of France. The Postmaster-General did not, he said, at present see his way to propose that the charge for a three minutes' conversation between the hours of 5 p.m. and 11 a.m.—the hours in which the telephone is now least in demand—should be reduced from eight to four shillings.

Light Railways in the Highlands.—In the House of Commons on Monday Mr. Baillie asked whether during the recess her Majesty's Government would enquire into the whole question of promoting a system of light railways on the west coast of the Highlands of Scotland, and would obtain such local information on the subject as would best bring out the particular claims of the various

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districts of the country for the development of their natural resources. In reply, the Lord Advocate said that the Secretary for Scotland fully recognised the importance of the subject, and intended to look into the matter and to give it his careful consideration.

Electricity v. Gas.—This is the way in which Mr. Wm. Bruce, of Leeds, opens a paper on "Gas Heating, Cooking, and Ventilation": "Gas engineers and manufacturers of gas stoves and cooking ranges have made many important improvements lately, and although gas is now largely used as a motive power, there is undoubtedly the disagreeable prospect before all interested in the manufacture and consumption of gas, from the producers' point of view, that at no distant date some of the large works fitted with the latest improvements may be found capable of supplying more gas than the consumption demands, owing to the progress of electricity for illumination."

The Ipswich Technical College. — The Town Council of Ipswich propose to convert Christchurch Mansion into a technical college, in which classes on the following subjects would be held: machine drawing and construction; applied mechanics; steam, magnetism, and electricity; electric lighting and telegraphy; sound, light, and heat; human physiology; biology; hygiene; principles of agriculture; botany; physiography; typography; manual training in woodwork; wood carving; wood turning; plumbing, painting, and graining; cooking; laundry and dress cutting-out. Commercial subjects: shorthand, book-keeping, geography, arithmetic, Latin, French, German.

The Queen v. Electricity.—The Queen is said to be a very determined opponent of the use of electricity, and to have forbidden its extension in any of the Royal palaces, so far, at any rate, as the apartments frequented by herself are concerned. Indeed, according to the London correspondent of a Manchester paper, she is adverse to the employment of electricity as a motive power for any purpose. The suggestion was recently made that the lifts which have to be erected in every building occupied by her should in some instances be actuated by electricity, and this suggestion was promptly rejected. Any hope, too, that may once have been formed as to the introduction of current for ventilating or for cooking purposes, has now, it is stated, been entirely abandoned by the officials concerned.

The Electric Light in Russia.—The passenger trains on the following Russian railways are to be electrically lighted before the close of the present year: Nikolai, Warsaw, Nishegorod, Rjasan-Ural, Kursk-Charkov-Azov, and Losovo-Sevastopol Railways. The project for the construction of a ship canal between the Baltic and Black Sea has now, it is stated, taken definite shape. The new canal will start from Riga, and following the course of the Duna, the Berezina, and the Dneiper rivers, will terminate at Kherson, on the Black Sea. It will be 1,600 kilometres, or 1,000 miles, in length, will have a depth of nearly 30ft. and a surface width of 200ft., and will measure about 100ft. across at the bottom. It will take five years to construct, and it is estimated to cost 200,000,000 roubles, or £30,000,000. At night the canal will be lighted by electricity, enabling vessels to traverse it in six days at the rate of about seven miles an hour.

Electric Tramways in Belgium.—It is stated that the Compagnie des Tramways Bruxellois has concluded a contract with the Berliner Elektricitäts-Gesellschaft "Union," whereby the latter firm engages to construct and complete within 12 months an electric tramway, five English miles long, from Schaerbeek to the Bois de la Cambre, Brussels, on the underground conduit system, as adopted in Budapest. The proposal of Colonel North to purchase a considerable area of Government ground at Ostend, on which to erect a large hotel and establish winter and pleasure gardens and villas has been favourably decided upon by the Upper House of the Legislature. The purchase also includes the right to work an electric tramway along the sea-front from the pier for a period of 99 years. Work upon the hotel and tramway will, it is said, be begun at once, in order to enable this portion of the undertaking to be completed by the opening of the exhibition in 1897.

The Grumbler Again.—This is a fair specimen of the style of the man who never posts a letter, despatches a telegram, or takes a railway journey without following the example of the famous young Etonian who, his Christmas cake having been somewhat "delayed in transit" by the railway company, ingenuously requested his father to "plese rite to the *Times*" about it:

TELEGRAPHIC ACHIEVEMENT.—Sir,—You have given so much space to recording the achievements in speed of railway companies that I hope in justice to a State department you will find a corner to record the fact that I have just received a telegram bearing the following startling dates: Leicester-square, 5 p.m.; Ludgate-circus, 5.42 p.m. The distance must be nearly two miles, and the telegraphic speed fully three miles an hour. We may scoff at the progress of the nineteenth century, but some of our grandmothers could hardly have walked the distance in less time.—Yours, X.

Some people never stop to think that it is but in consonance with human nature that of the trillions of letters, telegrams, and railway trains despatched in the course of a year one must now and again go wrong.

Machinery Exhibition at Vienna. — We have received the following communication from the Imperial and Royal Austro-Hungarian Consulate-General, 11, Queen Victoria-street, London, E.C.: "Encouraged by the great success of the exhibition of agricultural machinery held at Vienna during May last, the I.R. Agricultural Society in Vienna has decided to hold a second exhibition in May next year. The prospectus will include not only agricultural machines, in the strict sense of the word, but appliances used in all branches of industry connected with agriculture, such as breweries, distilleries, yeast, sugar, vinegar, and starch factories. The mart will also extend to tools and engines used in forestry, saw mills, celluloid factories, orchards, vineyards, in the feeding and breeding of cattle, horses, fish, etc. It will comprise electrical machines in the service of these industries, seeds, and manures. Provisional applications for space (which will not be considered binding) will now be received by the Committee of the Second International Exhibition of Machines, I. Wien, Herrengasse 13, Austria."

Obituary.—We regret to have to announce the death, on August 30, of Mr. H. C. Hart, one of the first-class technical officers of the engineer-in-chief's office, Post Office Telegraphs. Mr. Hart joined the telegraph department in June, 1870, shortly after the transfer of the companies' business to the State. He has throughout his official career taken a keen interest in the great developments of the telegraph and telephone industries and in Post Office work generally. He was a director of several of the mutual associations started and managed by Post Office men for the benefit of their brother officers. His loss will be deeply deplored by all with whom he was brought into contact. The interment took place on Monday, the 2nd inst., at Elmer's End Cemetery. Among those present to render a last tribute of respect to their late colleague were Mr. J. Hookey (assistant engineer-in-chief), Messrs. J. B. Chapman, T. H. Stockwell, P. Ennis, J. W. Curra, R. C. Lever-

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sedge, T. Reid, and J. Ward (of the engineer-in-chief's office), and many representatives of other branches of the Post Office. The deceased gentleman was 49 years of age.

Light Railways in Essex.—The proposed opening up of the remote parts of Essex by means of light railways is assuming a practical shape, and is deserving of sympathetic encouragement. The Hon. Charles Strutt, the member for the Maldon division, showed his interest in the scheme by presiding over the conference of landowners, farmers, and manufacturers at Tiptree Heath which considered the matter, and that meeting approved the idea of a light railway from Kelvedon to Tollesbury, on the Essex coast. It was stated that the line could be constructed for some £1,500 per mile, including purchase of the land, and a deputation to wait on the Great Eastern Railway Company, to ask their assistance, was appointed. At the figure mentioned, a light railway through an agricultural district at present destitute of all facilities for locomotive traffic ought to be a commercial success, but if it is to serve as a feeder to the existing railway, it must, even though the permanent way is less solidly built, be of the same gauge, for to reload the traffic when it reached the Great Eastern line would be to destroy much of the advantage of the proposed new railway.

Personal.—On Tuesday last a farewell banquet was given by the works staff of Messrs. Siemens and Co., in the Holborn Restaurant, to wish success to Mr. E. Weegmann in his new sphere in Germany. Mr. Weegmann has been connected with the above-named firm for 14 years, and has for a number of years had the control of the construction of the dynamos, alternators, etc. He has in this capacity gained the esteem of his colleagues by his uniform courtesy. A large number of the staff were present, under the chairmanship of Mr. F. Hurd, who, after the loyal toasts had been duly honoured, referred in a well-worded speech to the regret they felt at losing Mr. Weegmann. He had for years shown great kindness and consideration to those with whom he came in contact in the works, and had smoothed the little inter-department trouble by his geniality. In proposing the health of their departing friend he would wish him, in the name of all present, great success in his new work. Mr. Weegmann, who is leaving England to take up an important Government post in Germany, in reply said that he was proud to have made so many good friends in England, and that he should always remember his fellow-workers at Siemens and Co. with pleasure.

Chinese Telegraphy. — Telegraphy, Dr. G. E. Morrison says, has reached a stage of development in Yunnan which portends well for the future of the Indo-(or more correctly Burmah) China overland wire. The Chinese telegraph code is simplicity itself. The code-book consists of 10,000 numbers of four numerals each, and each group so constituted represents a Chinese character. Any operator, however ignorant, can thus receive or telegraph a message in Chinese, and the Chinaman's memory is so prodigious that he rapidly learns all the essential parts of the code-book by heart. The system, moreover, permits of the easy arrangement of undecipherable private codes, which are extensively used, since, by adding or subtracting a certain number from each group of figures, other characters than those telegraphed can be indicated. It is claimed for Chiang, the second Chinese clerk in Yunnan, that he knows all the 10,000 numbers and their corresponding characters by heart. The telegraph is very largely used by the Chinese, especially by bankers, in making telegraphic remittances. Telegrams from Yunnan to Shanghai cost the equivalent of 6d. for each Chinese character, but each word in any other language is charged double.

An Electric Snowstorm is the very latest Yankee discovery. Lieutenant John P. Finley, "one of the best-informed meteorologists in the country" encountered it while making an ascent of Pike's Peak. He says the storm could be described "as a shower of cold fire. In reality it was so charged with electricity as to present a scene more easily imagined than described. At first the flakes only discharged their tiny lights on coming in contact with the hair of the mule on which the lieutenant was mounted. Presently they became thicker and faster, each flake emitting its spark as it sank into drifts of the snow, or settled on the clothing of the lieutenant or the hair of the mule. As the storm increased in fury and the flakes became smaller, each of the icy particles appeared as a trailing blaze of ghostly white light, and the noise produced by the constant electric explosions conveyed an impression of Nature's power which Lieutenant Finley will never forget. When the storm was at its height and each flake of snow was like a drop of fire, electric sparks were shaken in streams from the lieutenant's finger tips, as well as from his ears, beard, and nose, and a wave of his arms was like the sweep of flaming sword-blades through the air, every point of snow touched giving out its little snap and flash of light."

Our First and Only Electric Mountain Railway, the Snaefell line, is meeting with such conspicuous success that extensions are already being talked of. A Douglas correspondent writes: It is not probable that this undertaking will end at the top of Snaefell. Already there are rumours of a scheme for continuing the line through Sulby Glen, and connecting it with the railway system between Douglas and Ramsey. The distance to be traversed by the connecting line need only be about four miles; the gradient is an easy one, and the cost much less per mile than that of the line which has just been completed. At the head of Sulby Glen are grounds which are already resorted to by thousands of visitors during the summer, and as the suggested connecting line will pass through these grounds, the promoters will have a certain amount of assurance as to the financial result of the scheme. One of the great advantages of this new line will be that by means of the electric system between Douglas and Snaefell, and the connecting line through Sulby Glen to the Manx Northern Railway, visitors would be able to make a circular tour, returning to Douglas by train, which will reveal to them the chief features of Manx scenery in mountain and glen. There is little doubt that some scheme of this description will be carried out, though whether the Snaefell Tramway Company or the existing railway companies will take the matter up, is not yet known. The latter are viewing with some concern the effect of the operations of the electric tramways upon their traffic, and it will probably lead them to take steps somewhat on the lines indicated.

The Westinghouse-Baldwin Combination.—From details which are published of the recent arrangement between the Westinghouse Electric and Manufacturing Company and the Baldwin Locomotive Works, of Philadelphia, it appears that the union is not the close one which has been represented, and that it merely amounts to a business agreement whereby the Westinghouse and Baldwin companies will each manufacture the parts of electric locomotives and high-power cars for which, by shop equipment and experience, the one or the other is the better fitted The former company will, of course, supply the electrical equipment and the other the remaining part of the rolling-stock. This is a natural arrangement, and similar in some respects to that which has existed for some time between the General Electric Company and the Schenectady Loco-

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motive Works. At the Baldwin Works draughtsmen are busily working upon plans for the new type of electric locomotives which the Baldwin-Westinghouse combination intends to produce, and an engine after the new design will, it is stated, be ready for inspection in about a fortnight. Two trucks will be made—one for light work and elevated roads, the other for the heavier class of suburban traffic, suitable for hauling 12 or 15 cars. These trucks can, we are told, by fitting them with motors of different power, "be made to serve all the requirements of electric roads, from the lightest elevated, with a maximum speed of 40 miles an hour, to the fastest suburban work of 90 miles an hour." It may be noted, by the way, that the construction of the Washington and Alexandria, Virginia, Electric Railway has been commenced, for which the trolley will be used outside the city and the underground conduit inside, while in crossing the Potomac the tracks of the Pennsylvania Railroad will be utilised; and that the Johnson Steelworks at Loraine, Ohio, have been awarded a contract for 30,000 tons of steel rails for the electric road between Washington and Baltimore.

Electricity v. Steam.—A writer in *Herapath's Railway Journal* discusses this subject. The directors of the Metropolitan Railway at the present time, and indeed the British railway world in general, must, he says, have their thoughts turned afresh to the possibility of utilising electricity as a tractive force for railway purposes. Hitherto, with the exception of a few tramway lines, the little railway at Portrush, and the new mountain line in the Isle of Man, electric traction has mainly been confined to the City and South London Railway and the Liverpool Overhead Railway. In the United States, on the other hand, electricity has been much more largely utilised. For street railways it is coming into general use, and the question is being actively discussed in railway circles whether it should not displace steam on the large trunk lines. A few weeks ago, when the arrangement between the Westinghouse Electric Company and the Baldwin Locomotive Works was announced, it was deemed probable that it would herald a new departure, and this view is largely shared across the Atlantic. Already a good many branch lines of ordinary railway utilise the new force, and the threat is held out that it will be possible to parallel the larger railways with electric lines, which can be worked cheaper for certain classes of traffic. The New Haven road is equipping its Nantasket beach line electrically, the Pennsylvania Railroad is introducing electricity on its Mount Holly branch, and the Baltimore and Ohio is using electric locomotives in its Belt Line tunnel, whilst experiments are under way at Chicago and other points in the like direction. Dr. Louis Duncan, president of the American Institute of Electrical Engineers, is of opinion that if the trunk lines do not recognise and absorb the new rival the latter will absorb them; at any rate, will dissipate the narrow margin which now remains over and above after meeting fixed charges. Electricity he considers peculiarly well adapted for trains running at short intervals and at high speed, and this would answer most of the requirements of passenger traffic. For goods traffic he does not consider electricity in its present stage suitable, because of the irregular service and the unequal distribution of the load along the line. In order to maintain dividends, he says, most of the two-track roads will either have to build additional electric lines or else control those that he feels sure will parallel them.

Electric Clocks.—The idea of applying electricity to timekeeping is by no means new, but the system, after a long spell of comparative quiet, has recently come to the front with a bound. The British Government has lately had the whole of the outdoor departments at Woolwich Arsenal fitted with these clocks, and they are in use, in London, at the South-Western District Post Office, as well as at the Mint, the telegraph works at Mount-pleasant, the Hugh Myddelton Board Schools, the Army and Navy Stores, Liverpool-street Station, and in other public buildings of the Metropolis. Owing to the great care which has been taken in the insulation of the wires conveying the electric current and in placing them secure from contact with all telephone, telegraphic, and electric lighting wires, not a single deviation in the matter of correct timekeeping has, it is stated, been observed in all these clocks during the recent severe thunderstorms in London. Amongst the private residences where electric clocks are in successful working is Blagdon, Sir Matthew White Ridley's seat in Northumberland, where the present Home Secretary, who takes the greatest possible interest in electricity, has such appliances fitted up for every conceivable purpose. In Great Britain, the city of Glasgow apparently first led the way in the use of the new timepieces. The Council of that city, having decided to place synchronised clocks at the corners of all the principal streets of the city, took steps to discover the best means of accomplishing its object, and after a careful trial of several systems under the superintendence of Prof. Becker, of Glasgow Observatory, it was decided to tentatively adopt the system of the Standard Electrical Time Recording Company, of Belgium, and the work of preparing and constructing the trial installation was entrusted to Messrs. J. J. Stockall and Sons, of Clerkenwell. First of all there is a main clock, which makes an electrical contact every half-minute, and transmits the current to as many receiver-dials as may be connected with it, thus causing the hands of all the dials to move automatically each half-minute. To ensure the accurate timekeeping of the main clock it is fitted with a Ritchie pendulum, which receives a current of electricity from the observatory clock every second. The pendulum thus controlled is absolutely compelled to keep time with the observatory clock. In connection with the system an elaborate switchboard has been arranged, which will be placed in circuit with the town clocks. By its means a break or interruption can at any time be detected, and the locality of the damage determined.

The Effects of Lightning.—The correspondence on this subject which is taking place in the *Times* has produced one or two letters of tolerable interest. Mr. G. J. Symons writes: "The bifurcation and ramification of lightning are so frequent that they may almost be regarded as its general characteristic. I am sure that I have more photographs of divergent than of single-track lightning. As regards double injury by one flash I can (without searching) quote three instances: (1) a corner house in Camden-square, N.W., struck at two points 25ft. apart; (2) two oaks in Richmond Park, many feet apart, were struck, one being damaged much more than the other; (3) the following is the verbatim report, dated January 18, 1889, of my late friend, Mr. James Sidebottom, of Millbrook, Hadfield, Manchester: 'There was one immense discharge, a few years back, right over my brother's cotton mills, a huge ball of fire bursting into fragments and striking some dozen different points, one being the flagstaff of a Roman Catholic church about a quarter of a mile distant.'" Sir Charles S. King, Bt., of Fermanagh, reprints a quaint tale: "The Rev. Dr. William Henry, F.R.S., a very close and careful observer, describes in his 'Description of Upper Lough Erne in 1729' (published 1892), the accident to Belturbet Castle, the seat then of Viscount Lanesborough, by this globular lightning, which seems worth quoting: 'About 20 years ago (1719) this

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castle was struck in an extraordinary manner with lightning, the traces of which are preserved to this day, and seem to confirm the philosophical opinion that what the vulgar call the thunderbolt is only the focus of that stream of liquid fire which is then discharged. This thunder struck the top of the castle close by the stack of chimneys, from which it shot down perpendicular to the bottom. The hole it made in the garret ceiling through which it darted is scarce 3in. diameter. This seems to be the very focus; from thence diffusing it knocked to pieces the stone of the hearth, and cut to itself a circular passage about 3ft. diameter; descending to the next floor, and growing more diffused, it cut through the hearth and floor a passage of about 8ft. diameter; from thence descending into the hall, and spreading wide, it, by the violent concussion of the air, dashed down two stands of arms hung round the hall, and broke out of the door, tearing down one side of it. Two women were in the hall—the one who stood on the further side, near the arms, was struck down, astonished but not hurt; the other, who was that instant shutting the door, was struck half dead; that side of her next the lightning was left all black, the other not in the least discoloured; she in a few days recovered and attended me at the time I observed this progress of the thunder.'" Another correspondent adds his evidence to an instance of lightning striking a plurality of trees at the same time. He was trout-fishing many years ago near the top of a mountain in America, when a heavy thunderstorm came on. He sought shelter under a large projecting rock; a "heavy explosion of electricity partially stunned" him. After the storm had passed he found that the lightning had struck seven chestnut trees within a radius of about 100 yards, all about 12in. in diameter, very tall, and all on the same side as that from which the storm was approaching.

The Telephone Newspaper.—A Vienna correspondent, who recently visited Budapest, furnishes some particulars concerning the *Telephone Hirmondo*, or *Herald*, which has now been working, apparently successfully, for over two years in the Hungarian capital, although when its conception was first mooted the idea encountered considerable ridicule. "While I was dressing in the morning," the correspondent relates, "the hotel servant knocked at my door and asked if I wanted the telephone paper. He then handed me two receivers about the size of a pocket watch, attached to long cords, which can be fastened to the bed or arm-chair to suit one's convenience. 'The newspaper will begin to speak directly,' remarked the servant, 'and will go on speaking till late in the evening. We don't charge our visitors anything for it, as it only costs us a penny a day.' Though only lately introduced, the telephone newspaper has become almost indispensable; it is to be found everywhere in this capital, and not only in places where persons require amusement or distraction, as in doctors' waiting-rooms, at barbers' shops, coffee-houses, restaurants, and shops of all kinds, but also in the offices of merchants, bankers, and lawyers, in hospitals and private houses, for the use of aged people to whom reading is fatiguing. It speaks all day, but does not give the news in a chaotic jumble, but minute by minute. It is imparted in strict accordance with the programme received by each subscriber. In this way each person knows when the turn will come for the news interesting to him. It was half-past eight when I put the receivers to my ears, and the day's work commenced for the newspaper. It began by transmitting the telegrams received in the night from Europe and America in a clear sonorous tone, quite free from the nasal twang of the ordinary telephone. This went on till a quarter to nine, after which followed the daily calendar with metropolitan news, and the list of strangers who had arrived at Budapest up to the previous night. At nine, official news, contents of the official gazette, etc., were given. From a quarter to ten until a quarter past ten came a review of the Vienna and Budapest morning papers; from a quarter-past ten to half-past ten reports on the opening of the stock and corn exchanges; from half-past ten to eleven local and ecclesiastical news, with theatricals, art and science notices. A quarter-past eleven to half-past eleven brought foreign, provincial, and sporting information; and from half-past eleven to a quarter to twelve reports arrived from the Vienna stock and corn exchanges, with all sorts of military, court, and political items. Early in the afternoon, when the sitting of the Reichstag begins, the parliamentary report is supplied every 10 minutes. The office is in telephonic communication with the Reichstag, and it often happens that important speeches from Ministers and members are known to the public while the speaker is still addressing the House. In this orderly way the programme is carried out until late in the evening. The latest reports from the stock exchanges, as well as foreign political news, are heard before any paper has printed them, and a short summary of all important items is given at noon, and again in the evening, for those who may have missed any of them. Music, art, and literature play important parts in this telephonic organ. Towards evening, when news is growing scarce, the subscribers are entertained with vocal and instrumental concerts, quartettes, and solos—the latter given by the most talented artists of the capital. The National Theatre is now within the circuit of the journal. The telephone newspaper abhors politics; it gives no leaders, only strictly chronicling in an impartial manner the opinions of other papers. It gives, however, original literary articles or feuilletons, and the latter, when written by some such favourite author as Maurus Jokai or Victor Rakosy, are frequently spoken into the telephone by the authors themselves, either from the editorial office or from their own desk telephone at home, placed for the purpose in communication with the office. This novel kind of lecture is heartily appreciated by the feminine public. All these benefits are showered upon the public for 1d. a day! Both wire and apparatus are conveyed free of expense to the subscriber's house. He is only under the obligation to subscribe for one year. The company started with a capital of 300,000fl., and have thus far invested 500,000fl. in the concern. The organisation of the staff resembles that of any other big paper. Ten men with strong voices and clear articulation act as speakers, and take their turns in shifts of two at a time. One of these speaks a series of items, but for no longer than eight or ten minutes, and every new item is introduced by the word 'new.' An emergency signal has lately been contrived by M. Szvetic, the head of the technical department. A shrill trumpet-like blast, audible in the whole room without connection with the receivers, sounds from both of them, warning the subscriber, if he be not at the time listening to the news, that an important event is about to be read. The 6,000 subscribers are served by one wire, measuring 168 miles in length, and running along the windows of the subscribers. Each subscriber forms a 'station.'" The founder of the *Telephone Hirmondo*, Theodor Albert Puskas, was a native of Transylvania and a friend of Edison. He had, it appears, an adventurous career. He at one time obtained from the municipal authorities of Antwerp an authorisation for the establishment of a telegraphic newspaper to be issued on the same basis as the later-conceived telephonic journal. He started the *Hirmondo* on February 15, 1893, and he died on March 16 of the same year at the age of 49.

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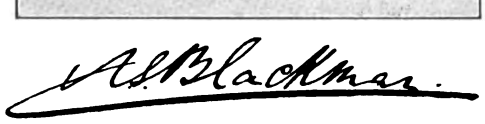
ABERDEEN ELECTRICITY WORKS.

Aberdeen has been brought very much under the public notice lately, it being the goal of the great race between the East and West Coast Railway Companies; the speeds attained in which have not only astonished the British public, but regained for the British Isles the honour of holding the record for fast-running expresses. The "Granite City" is situate between the valleys of the Dee and Don, and covers an area of 10½ square miles, the largest area of any town in Scotland. In 1871 it had a population of only 88,181, but owing to the great facilities for shipping and its splendid railway connections, its importance has so increased that it has now a population of 140,000. William the Lion gave the city a charter in 1129, and Cosmo Jones states that long before Edinburgh had acquired the precedency of a capital, or even the first place among the four burghs of Scotland, while Glasgow was yet an insignificant dependency on its bishop, Aberdeen had taken its place as a great and independent Royal burgh and a port of extensive foreign trade. Robert the Bruce gave the town its motto of "Bon accord," which was the watch-word when in 1300 the citizens stormed the castle, driving out the English garrison placed there by Edward I.



The Municipal Buildings, which are situated in Union-street, are a fine example of Franco-Scottish-Gothic architecture, the tower being 204ft. high, erected In 1867-73.

It is worth noting, in passing, that many of our illustrious shipbuilders and engineers have hailed from Aberdeen, amongst whom may be specially mentioned the late Dr. Charles Mitchell, of the great firm of Sir William Armstrong, Mitchell, and Co., Elswick, who spent large sums of money in promoting the cause of education in his native town and in extending the famous university of Aberdeen, which is the educational centre for the North of Scotland.

The history of the electric lighting movement in this city is briefly as follows: On November 27, 1889, a deputation, consisting of Councillor Cook, the gas treasurer (Mr. P. M. Cran), and the gas superintendent (Mr. Alex. Smith) sent in a report to the Town Council, which stated that they had visited the works of the London Electric Supply Company, St. James's and Pall Mall Supply Company, House-to-House Supply Company, Liverpool Electric Supply Company, and the Bradford Corporation, the result of which visits was that the Council decided to apply for a provisional order. On January 22, 1890, the Gas Committee decided to oppose the application of the Scottish House-to-House Company for a provisional order to supply electricity in the city, and on March 26, 1890, received intimation that the application was not to be proceeded with. The Electric Installation and Maintenance Company also proposed to undertake the construction of the necessary plant and to maintain the work for a fixed period on certain terms, which proposal was not favourably received by the Council. The Gas Committee on February 16, 1892, appointed a sub-committee, consisting of Bailie McKenzie (convener), Bailie Nicol, Councillors Bisset and Johnston, to obtain and submit information in regard to the systems of electric lighting in towns where it had been introduced. They visited the following stations: Bradford, Liverpool, Brighton, Dublin, and Newcastle; and upon their return recommended that Prof. A. B. W. Kennedy, of Westminster, should be requested to visit Aberdeen and report to the Town Council as to the best mode of dealing with the question. Prof. Kennedy, after visiting the town, advised the adoption of the three-wire low-tension system, with a supply at 110 and 220 volts, the estimated cost of the whole of the station—buildings, boilers, engine-room plant, switchboard, batteries, and mains—being £24,400. He also advised that the central station should be built on ground adjacent to the gasworks, and already owned by the Corporation, and thus enable the two undertakings to work together as much as possible. The committee adopted Prof. Kennedy's report, and in response to specifications issued by him the following tenders were accepted:

Station Buildings.

Mr. Robert Smith, Aberdeen, mason's work	£1,744	0	0
Messrs. Scott and Sellar, Aberdeen, concrete work	505	18	0
Messrs. W. McKinnon and Co., Aberdeen, ironwork	410	0	0
Messrs. Watson and Robb, Aberdeen, carpenter's work	351	0	0
Mr. W. W. Milne, Aberdeen, slater's work	95	0	0
Messrs. J. Blackie and Son, Aberdeen, plumber's work	77	0	0
Messrs. J. and S. Fyfe, Aberdeen, painter and glazier's work	63	0	0

A total of £3,245. 18s.

For Plant.

Messrs. Babcock and Wilcox, Limited, London, boilers	£1,494	0	0
Electric Construction Corporation, Limited, Wolverhampton, engines, dynamos, pumps, steam and other pipes	5,044	0	0
Messrs. Siemens Bros. and Co., London, switchboard, instruments, and connections	990	0	0
Messrs. Scott and Sellar, Aberdeen, roadwork	2,671	0	0
Electrical Power Storage Company, London, storage batteries	760	0	0
Messrs. T. Bolton and Sons, Staffordshire, copper strip	820	0	0
Callender Bitumen Telegraph and Waterproof Company, Kent, insulated cable	1,532	0	0
British Insulated Wire Company, Prescot, insulated cable	190	0	0
Messrs. Doulton and Co., London, insulators	176	15	8
Messrs. W. McKinnon and Son, Aberdeen, battery stands	56	0	0

A total of £13,733. 15s. 8d.; and for buildings and plant of £16,979. 13s. 8d.

At the Town Council meeting of June 5, 1893, it was decided to appoint an electrical engineer. Sixty-five applications were received, and Mr. Murray, of Larne, co. Antrim, was chosen, and held the position till February, 1895, when he left to take up the duties of electrical engineer to the Corporation of Worcester. Mr. A. S. Blackman, who was assistant at the time, was appointed *pro tem.*, and the economies he effected—chiefly by the substitution of coke for coal in the boilers—gained for him the confidence of the Corporation. When the applications for the post of electrical engineer to the city were considered, Mr. Blackman was elected by an overwhelming majority, only two voting against his appointment. Mr. Blackman was previously assistant to Mr. C. B. Smith, resident engineer to the Hove Electric Lighting Company, Limited, and also was for seven years with Messrs. Crompton and Co., Limited, both at their Chelmsford and London works.

The formal opening of the works took place on Tuesday,

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February 27, 1894, when Mrs. Stewart, the wife of the Lord Provost, switched on the light from the Town and County Hall. Amongst the speeches made on this occasion, one by Prof. Kennedy on the adoption of proportional rates is most interesting. Prof. Kennedy said that he had no doubt that the electric light would succeed and grow most rapidly; but he should like to say one or two things in particular about the best way to make it grow, and that was to do all they could to get the very biggest load on as soon as they possibly could, because half their whole expenditure was really fixed charges, perfectly independent of whether they supplied 2,000 units a week or 5,000 units a week. They would have to pay these charges even if the station were shut up, and therefore the more work they did the cheaper they could afford to do it. He had not spoken to any of his friends on the committee about it, but if there was any specially large installation that could be had on the Corporation mains it would be advisable for the Corporation in that case to make a special rate. They had power by Act of Parliament to do that. Suppose they were selling 2,000 units, it would cost them so much for wages, so much for coal and oil and stores and capital charges. If they doubled the 2,000 units by any chance, their expenditure would practically increase only 20 per cent., and their output 100 per cent. They could then afford to sell at a less figure, because the additional cost would only be the additional cost of coal, oil, wages, stores, etc. Hence the taking on of the additional 2,000 at 5d. might give them so much profit as to enable them to reduce all round to 6d. Thus the smaller consumers would get the benefit of 1d. per unit because they had given the larger consumers a reduction of 2d. He was not giving them a mere academic opinion, for he had under his immediate direction and control, in companies that he advised, something like 2½ million units, and he therefore did know something about the sales and profits of the electric light, and he believed what he had suggested was really the best method of reducing the price—making low rates all round, and so making the light thoroughly popular in the best sense of the word.

FIG. 1.—The "Town House," Aberdeen.

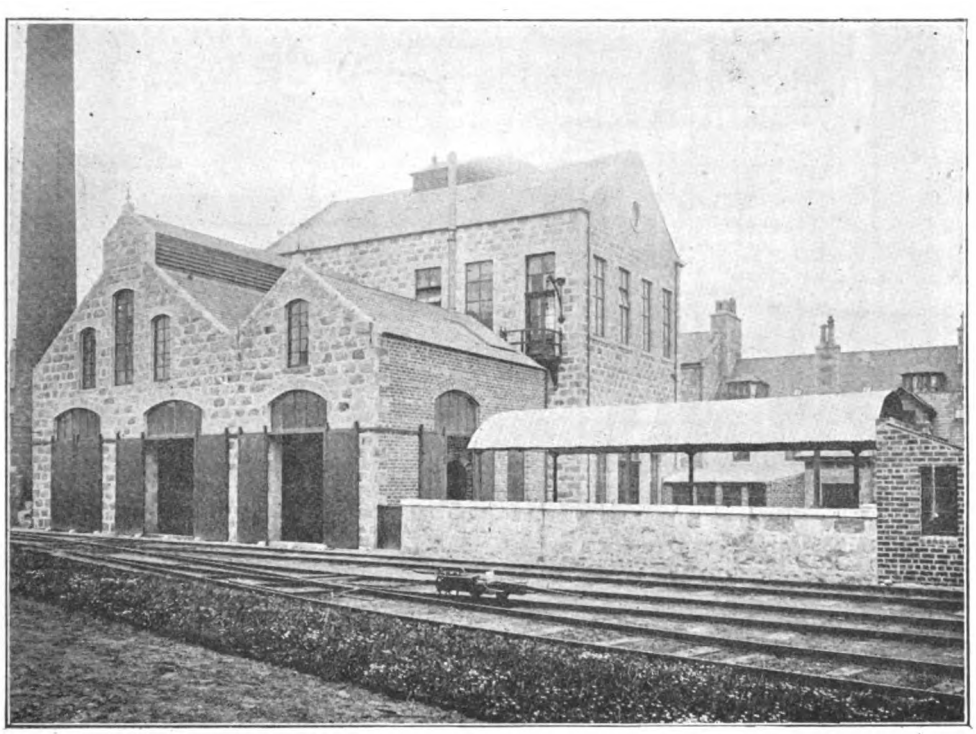

FIG. 2.—View of Electricity Works, Aberdeen, with Boiler-house and Coal-store in Foreground.

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As will be gathered from the foregoing, the price per unit was first fixed at 7d., but this has been reduced to 6d. for lighting and 4d. for motive power, the price for public lighting being 4½d. per unit. Beyond the reduction for electricity supplied for motive power, the Corporation do not seem to have adopted the reduction to large consumers advocated by Prof. Kennedy. Ten public arc lamps are in regular use, nine in Union-street and one in St. Nicholas-street. The poles used are of the swan-neck type, and are fixed in the kerbs of the footpaths.

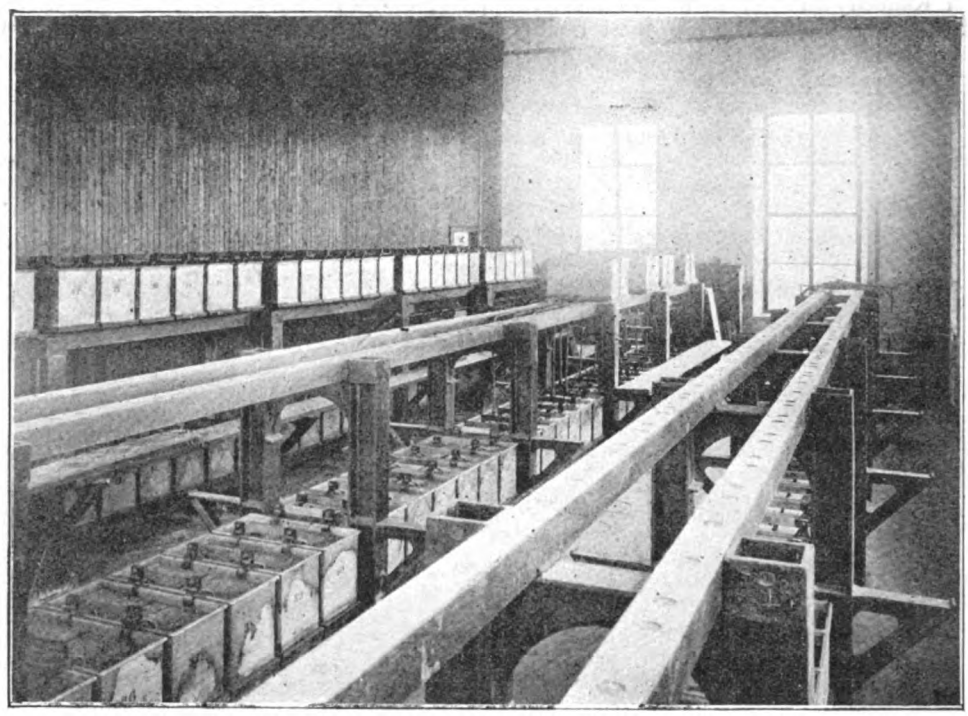

FIG. 3.—The Accumulator-room.

GENERAL DESCRIPTION OF THE WORKS.

The electric lighting station (Fig. 2) is situated on a plot of ground adjacent to the gasworks in Cotton-street, and is a substantial building of granite. On the ground floor are placed the engine-room, boiler-house, and coal-store, and the general offices. A flour-mill formerly occupied the site of the present works, and the old mill chimney has been heightened and utilised temporarily to save initial expense. Foundations are, however, provided for the new shaft at the back of the pump-house. The works are making such

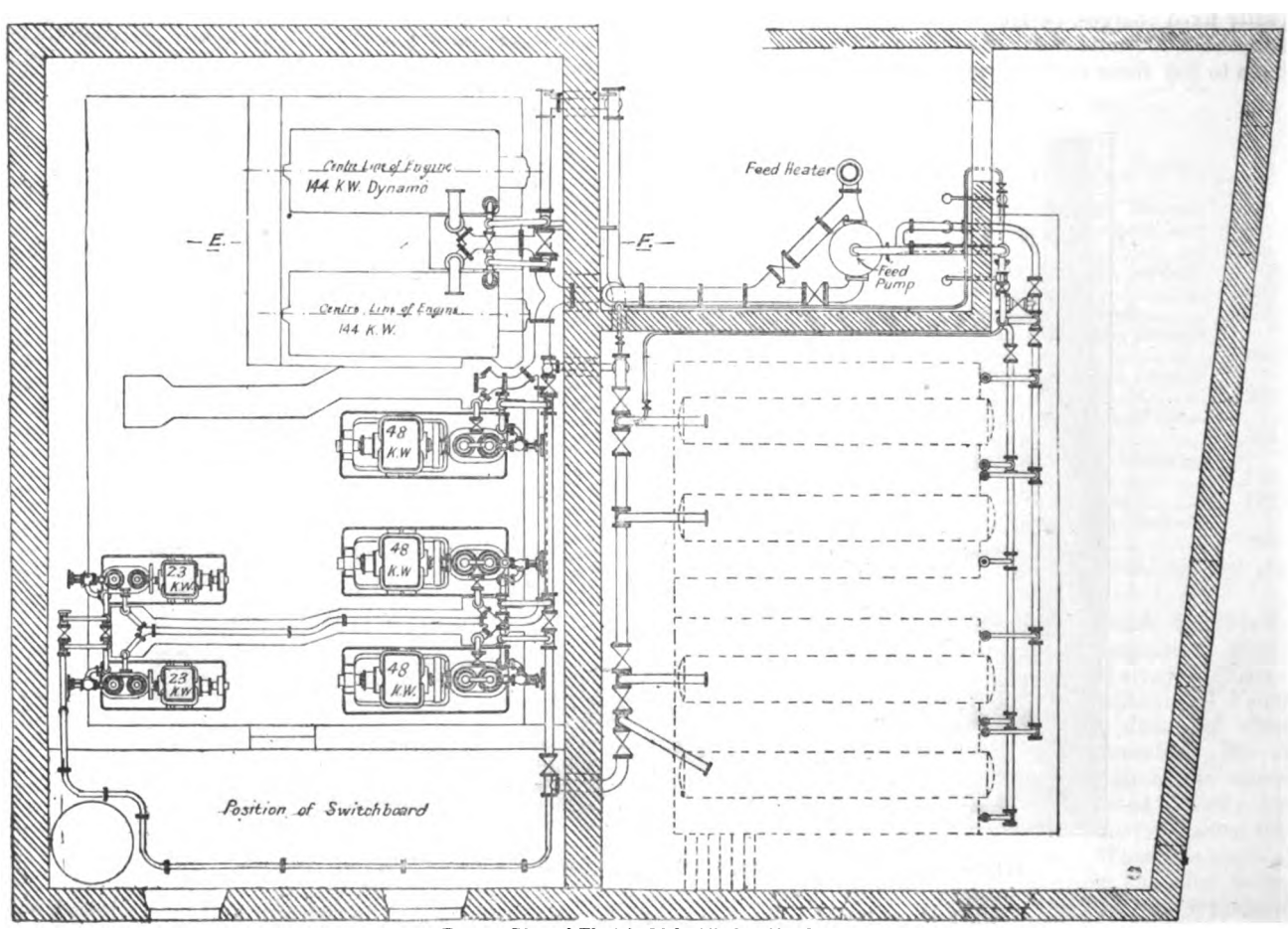

FIG. 4.—Plan of Electric Light Works, Aberdeen.

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rapid strides that it will, no doubt, soon become necessary to build this new shaft and to extend the engine-room and boiler-house, both of which are now practically filled up. There is, fortunately, plenty of ground available for extensions. On the first floor above the engine-room is situated the accumulator-room (Fig. 3). The floor of this room is built of iron and concrete, to be sufficiently strong to support the weight of the accumulators, and also to be watertight and fireproof. The workshop is on the same floor, and contains the usual vices and workshop appliances. The test-room opens off the battery-room. Upon a long table in the centre are placed the meters to be tested. Leads connected to the milking cells of the battery are brought in to a double-pole cut-out within the room. From there the current passes through a switchboard, provided with regulating resistances, having a capacity of 150 amperes, and also through a standard resistance to the meters.

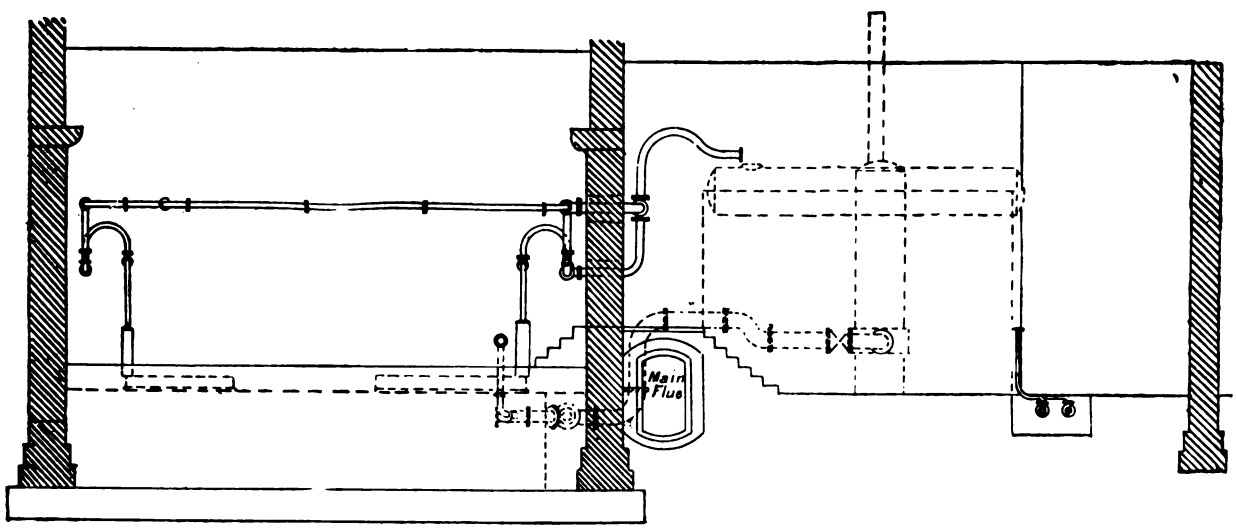

FIG. 5.—Elevation of Station.

GENERAL ARRANGEMENT OF PLANT.

The arrangement of the engine-room will be seen from Fig. 4. The generating plant first installed consisted of the following: two 40-h.p. Willans engines, direct coupled to Electric Construction Corporation dynamos, giving 170 amperes at 135 volts; three 80-h.p. Willans engines, direct-coupled to Electric Construction Corporation dynamos, giving 210 amperes at 230 volts. These were placed at the switchboard end of the room. Since the demand for light has so rapidly increased, there have been added two 200-h.p. Willans engines, direct coupled to Holmes dynamos, giving 500 amperes at 240 volts. It was found necessary to make these additions to the plant after only 10 months' running. A granite cornice running the full length of the engine-room on either side carries the rails of a six-ton ton travelling crane. The walls of the engine-room are tiled to a height of 6ft. A spare armature for each size of dynamo is placed in such a position that it would be at once available in case of emergency. Behind the engine-room are situated the boiler-house and pump-room. The main flue, as will be seen from the elevation, Fig. 5, is placed underground, and so arranged that it can be easily connected to the new shaft when built. The steam-pipes, which are arranged on the ring system, are placed over-

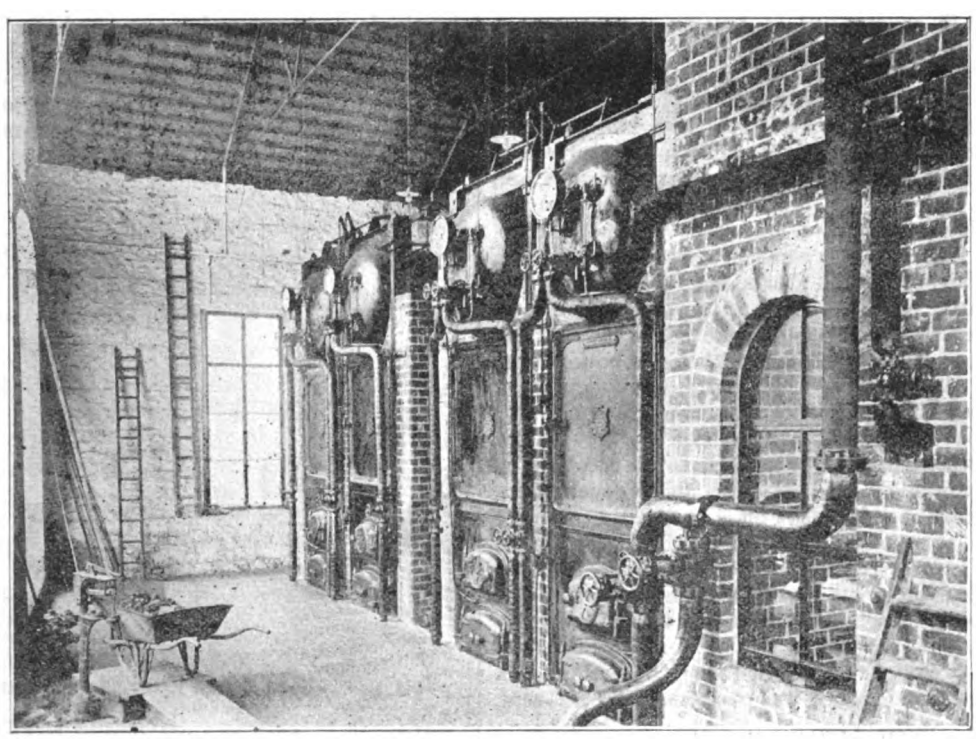

FIG. 6.—The Boiler-house, Aberdeen Electric Light Works.

A Crompton potentiometer is placed on an insulated slab at one end of the room, together with an Ayrton-Mather galvanometer and standard cell. Blinds are fixed to all the windows to enable the spot from the mirror galvanometer to be seen when testing on a bright day. Shelves for the meters, a desk, and Fuller's slide rule complete the equipment. The majority of the meters used are of the Ferranti V.D. type.

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head, and the exhaust-pipes are arranged in channels in the floors. As no sufficient supply of condensing water is at hand, no condensing plant has been installed.

Steam Generating Plant.

The boiler-room (Fig. 6) is 51ft. by 38ft., and is separated entirely from the engine-room. It contains four 90-h.p. nominal Babcock and Wilcox water-tube boilers, a special

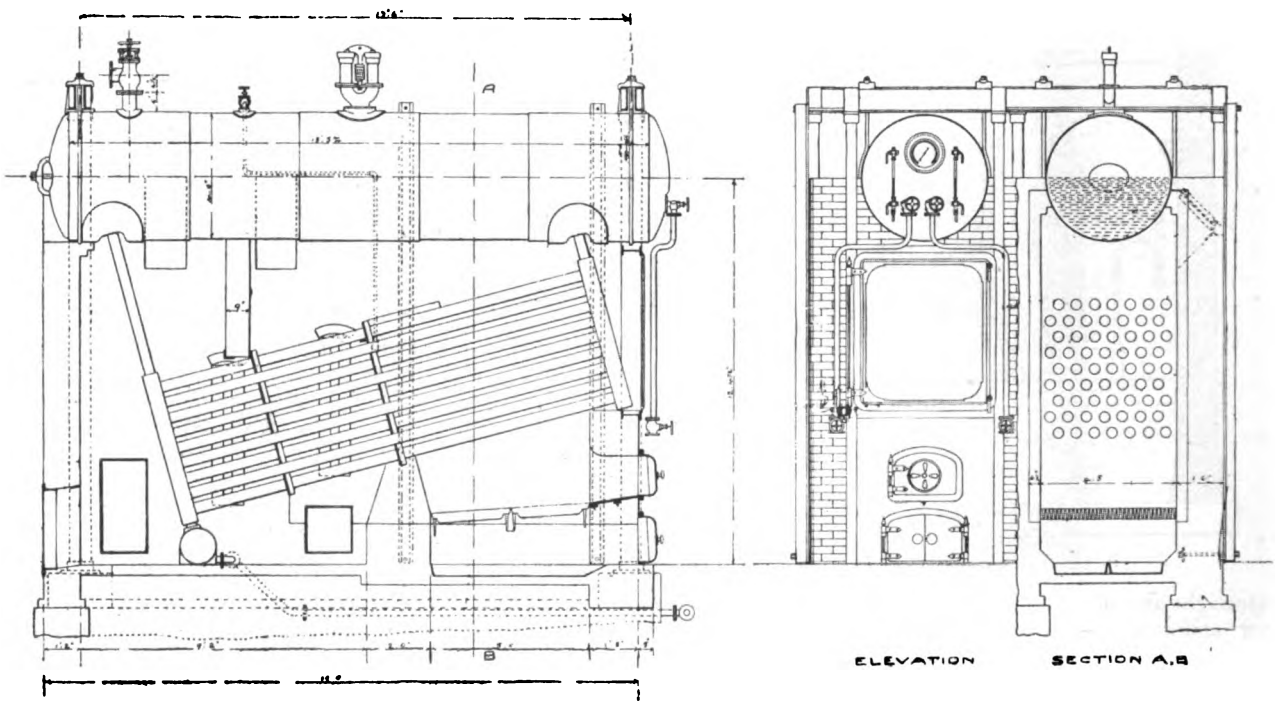

Fig. 7.—Side and End Elevation of the Babcock Willcox 90-h.p. Boilers.

feature of these boilers being the large steam-drums; these are 4ft. in diameter, to comply with Prof. Kennedy's specification. Two boilers are arranged together in one battery, as will be seen from Fig. 7, and each of these boilers has 1,123 square feet of heating surface, and is composed of seven sections of tubes, each section being nine tubes high. The tubes are 4in. diameter and 14ft. long. The steam and water drum is 4ft. in diameter, and the whole boiler is constructed for 160lb. working pressure, and was tested after erection to 250lb. per square inch. Each of the boilers has a duplicate feed arrangement, and has a grate 5ft. long by 4ft. 5in. wide. At first coal was used as fuel in these boilers, but since February, 1895, coke supplied from the Corporation gasworks adjoining has been exclusively utilised; this fuel is found to give most satisfactory results. Owing to the good water available no incrustation troubles have occurred, and Mr. Blackman assured our representative that the boilers were as clean as the day they were erected. A similar boiler has been in use in the adjoining gasworks for some nine years, and the engineer, when written to by Messrs. Babcock and Wilcox in 1893, stated that "it had been in action continually night and day for about seven years, with the exception of a few days off occasionally to repair the sides of the furnace with firebricks, that it had never cost a penny for any repair in connection with the iron work, and had given great satisfaction and had surpassed his highest expectations." He also stated that nothing but the worst quality of coke from cannel coal was used for firing it, and that the saving of fuel over the two Cornish boilers working alongside of it was upwards of 25 per cent.

Feed Arrangements.

There are in the pump-room two feed pumps of the Worthington type, vertical pattern, brass fitted, and suitable for working constantly at a pressure of 160lb. per square inch. Each pump is capable of easily delivering water to the boilers, against the full steam pressure, at the rate of 3,000 gallons per hour, and if pressed is able to deliver 4,500 gallons per hour. The necessary pipes and valves are provided to enable each pump to receive its steam from either of the two main ranges of pipes. These pipes are of copper. The feed-pipes are in duplicate between the pumps, heater, and boilers, and are so arranged that each pump can feed through either range of pipes, through the heater or direct to the boilers. The system of pipes for this purpose is provided with all necessary valves—relief-valves, cocks, etc.—for two pumps, one heater, and four boilers. The relief-valves are arranged to pass all waste water back to the feed-tank. The branches and flanges are so arranged that two more pumps, a second heater, and another line of boilers can be, without difficulty, connected up to the existing plant. The starting valve of the pumps is so placed that the stoker on duty can readily work them from outside the pump-room. All the feed-pipes are of copper, and the feed relief-valves on them are set to lift at a pressure of 180lb. per square inch. One exhaust feed-heater is placed close to the feed pumps. This is of the Berryman type, and was made by Messrs. Joseph Wright and Co., of Tipton. The heater is

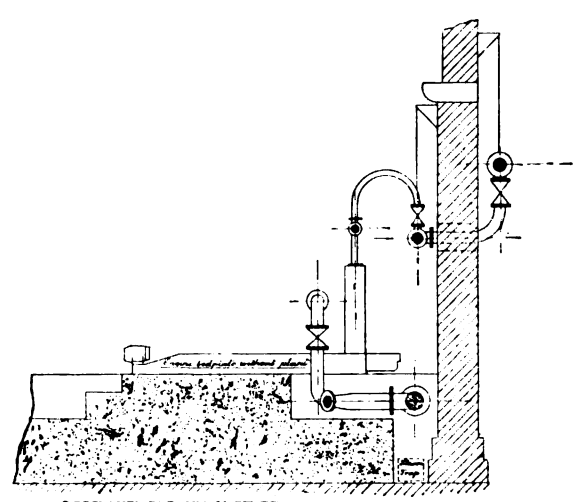

Fig. 8.—Steam and Exhaust Pipe Connections to the 200-h.p. Sets.

constructed to work at a pressure of 150lb. per square inch, and to raise 17,000lb. of feed water from 60deg. F. to about 206deg. F. The heating surface consists of solid-drawn brass tubes. Each tube is bent into the form of a ∩ and expanded at the ends into one tube-plate only, which leaves the tube free to expand in any direction without being strained at the joint. This construction makes leaky joints impossible. The feed-tank is placed below the pump-room in a space excavated to receive it.

Steam and Exhaust Pipes.

The steam-piping is arranged on Prof. Kennedy's ring

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system, which provides that there are always two ways for supplying any engine with steam. The whole of the pipes are of copper throughout, with faced wrought-iron or steel flanges brazed on. All pipes under 3in. in diameter are of solid-drawn copper. The T-pieces are of cast iron. Every part of the system was tested by hydraulic pressure up to 350lb. per square inch. The whole of the steam-mains in the engine-room are slung by rods from suspending brackets.

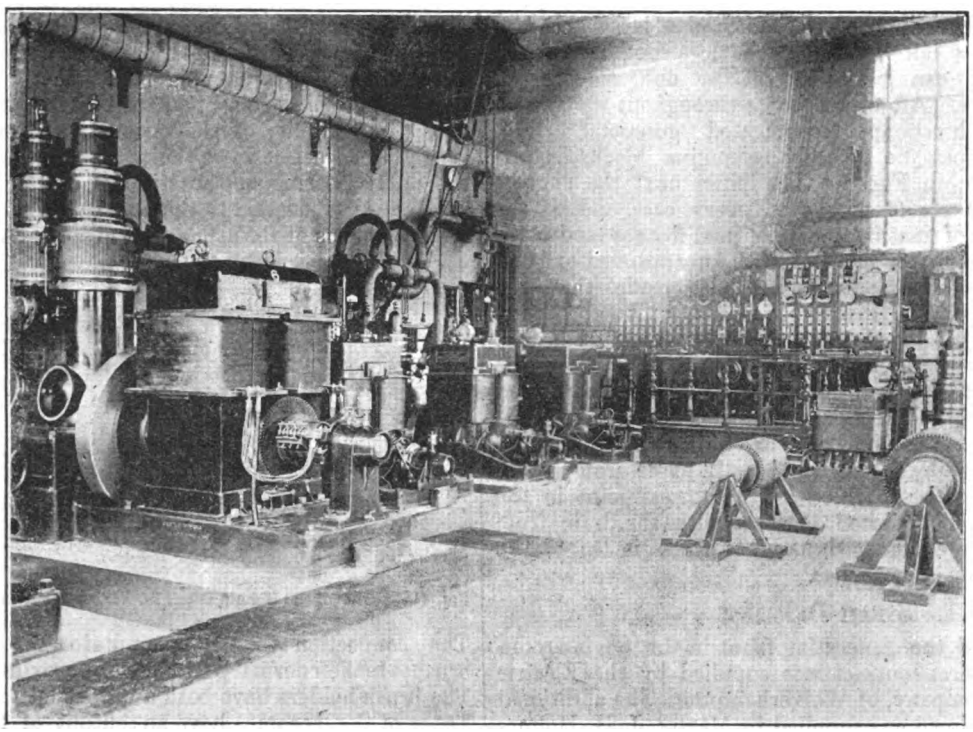

FIG. 9.—View of the Engine-room from the Office Entrance.

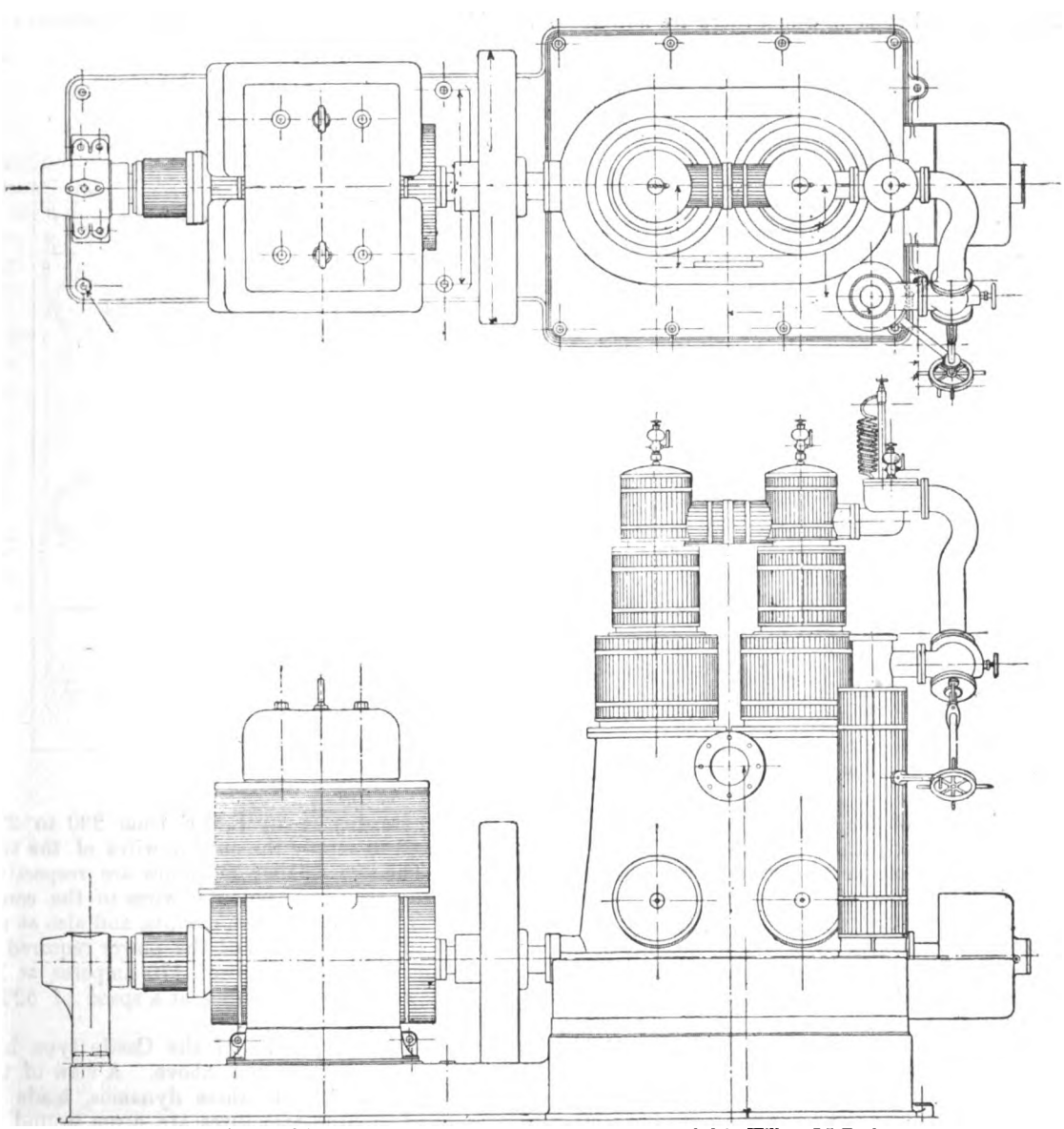

FIG. 10.—Plan and Elevation of the 120-K.W. Castle Dynamos, coupled to Willans I I Engines.

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Suitable supports or slings are also provided for the steam-pipes in the boiler-house. There are some 16 valves in all in use on the steam rings, varying in diameter from 7in. downwards. The slope of the steam-pipe is so arranged throughout that all water which does not flow back to the boilers can be taken off by one or other of the drain valves. All steam joints throughout the system are made with stamped corrugated gunmetal rings. The exhaust-pipes lie round the engine block in the positions shown in Fig. 4. The pipes next the engines (vertical bends) are of copper in every case, and all the other pipes are of cast iron, with turned flanges and faced joints. Each engine is supplied with an approved exhaust (sluice) valve. Arrangements are also made that the exhaust steam can be discharged directly into the atmosphere without passing through the feed heater if necessary. The main exhaust-pipe is carried up beside the wall of the pump-house in the position shown, Fig. 4. It is a galvanised wrought-iron pipe, $\frac{1}{8}$in. thick, and having a diameter of 10in. inside. It is made in lengths of about 10ft. each, the joints being made by flanges of $1\frac{1}{2}$ by $1\frac{1}{2}$ angle iron riveted on. A drain-pipe is provided at the lowest point in the exhaust. This is connected, together with the drain from the heater, to a common drain-pipe, which is led to the main drain of the boiler-house.

Steam Dynamos.

The whole of the generating plant in the engine-room (Fig. 9) in the first contract was supplied by the Electric Construction Company, of Wolverhampton. The additional plant since laid down was supplied by Messrs. J. H. Holmes and Co., of Newcastle-on-Tyne. The engines are Willans's central-valve compound type, of which there are now seven in the station—*i.e.*, two of the E E size, indicating 38 h.p. at 520 revolutions; three of the G G size, indicating 80 h.p. at 440 revolutions; two of the I I size, indicating 200 h.p. at 350 revolutions. Each engine is provided with a governor, so adjusted that if half the whole load be suddenly thrown on or off the variation of speed does not exceed 5 per cent., and that under no condition whatever does the engine race injuriously. Further, as the regulation of the dynamos is mainly carried out by an alteration of the resistance in the shunt, the governor is so proportioned as to maintain control over the speed of the engine throughout its whole range from no load to full load. Each governor is readily adjustable while the engine is running at various speeds. Each engine is fitted with a speed indicator, and also with a steam-pressure gauge in a convenient position, connected to show the pressure of steam in the high-pressure valve-chest. Sight-feed lubricators also are provided with each engine.

All the dynamos made by the Electric Construction Company are of the simple shunt-wound continuous-current type with drum armatures. There are five of these dynamos in all, having corresponding parts strictly interchangeable. In the design of the machines special attention has been given to the accessibility of the various parts for ready renewal, repair, or adjustment, to the arrangements for lubricating the outer bearing, to the stiffness of the spindle and its mechanical connection to the armature, and to the insulation of the sections of the armature and commutator throughout.

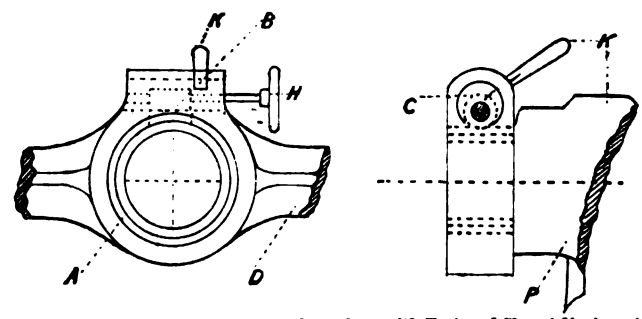

Fig. 11.—Sketch of the Holmes Brush Rocker, with Fast and Slow Adjustment.

The connection to the commutator are such that the brushes in their normal position are approximately horizontal. The brush-holders have both a quick and a fine adjustment. Three of the dynamos have an output of 210 amperes at 230 volts (or, say, 48 kilowatts) when running at a speed of 440 revolutions per minute. These dynamos are capable of running steadily at any E.M.F. from 220 to 275 volts, and are used to supply the outside wires of the three-wire system. The two smaller machines are respectively connected across from the two outer wires to the centre wire. In this way they balance the circuits, and also at moderate loads can supply the whole of the power required. These two dynamos have an output of 170 amperes at 135 volts (or 23 kilowatts) when running at a speed of 520 revolutions per minute.

The two large dynamos of the Castle type have most of the characteristics stated above. A view of these sets is given in Fig. 10. In these dynamos, made by J. H. Holmes and Co., the armatures are drum wound, and connected in such a way that the brushes are horizontal. The brush-rocker supporting the brush arms, etc., is arranged to have both a fast and slow adjustment in the following in-

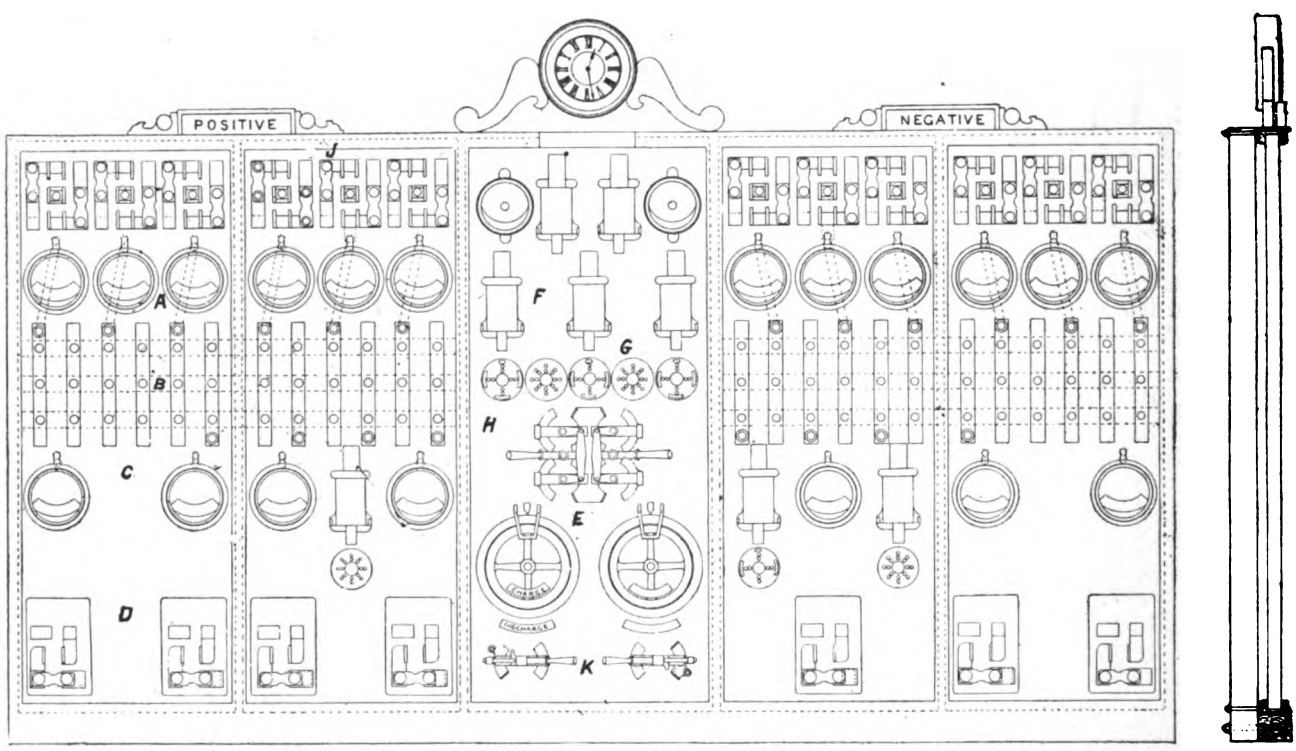

Fig. 12.—Elevation and Section of the Switchboard made by Siemens Bros. and Co.

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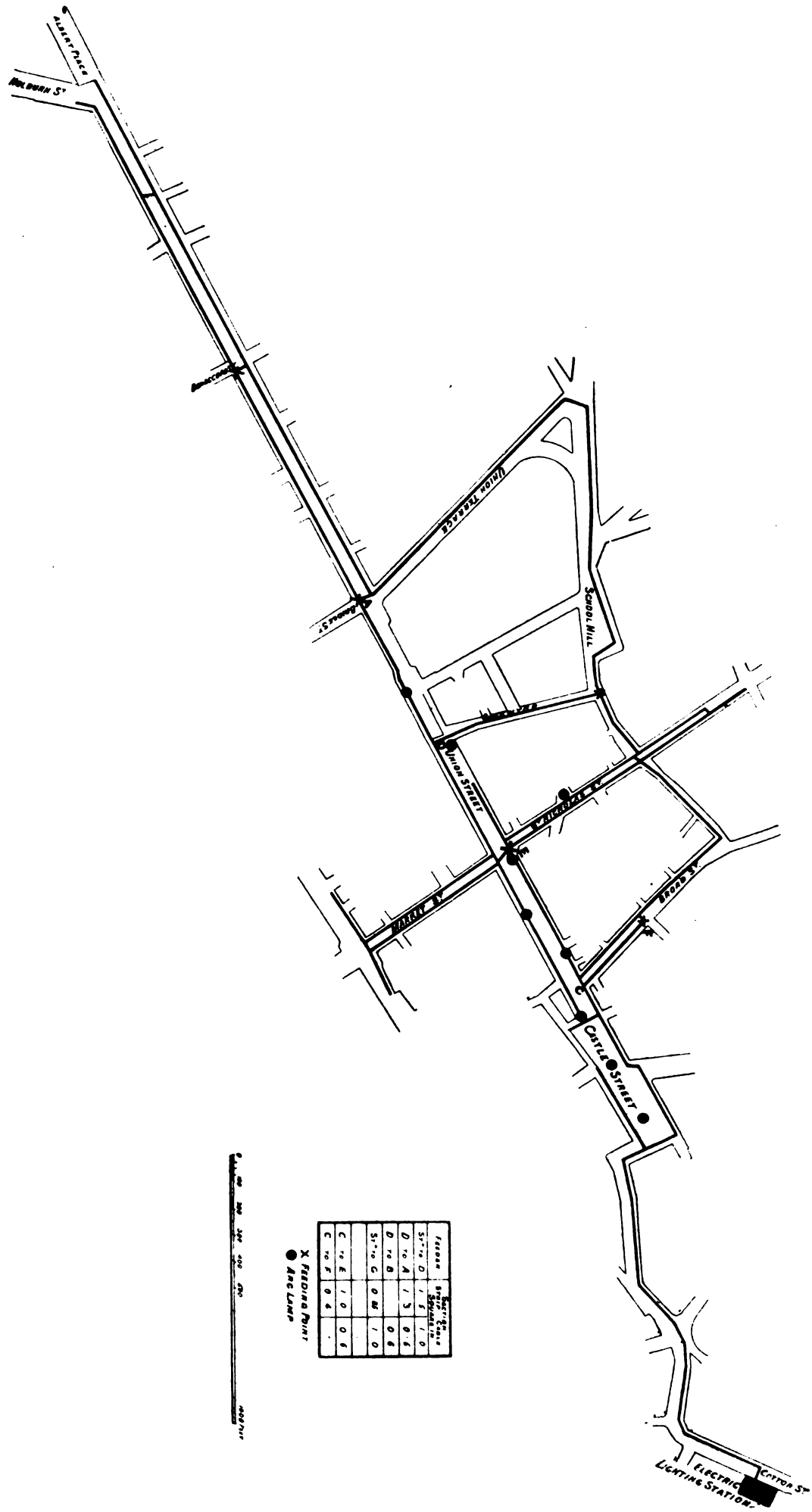

Fig. 13.—Plan of Streets supplied up to date, showing Feeding Points and Arc Lamps.

genious way (Fig. 11 shows a sketch of the essential parts): A is the metal ring firmly attached to the pedestal, P, and having worm-wheel teeth cut in it. The worm, B, which is keyed to the spindle driven by the handle H, gives the slow adjustment of the brushes when in gear with the worm-wheel.

(Continued on page 267.)

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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STREET-LIGHTING.

There are such a number of traditions, financial and otherwise, binding electrical engineers in matters of street illumination, that the question is seldom considered from a practical standpoint. We cannot understand why the lighting committees, after having paid for an inferior light for years at a fair rate, should expect to get ten times the light for about the same money. Such is the expectation where cost is considered, and the result in such cases is either that the electric lighting company or department has to supply a good light at a price totally unremunerative, or that the arc lamps are scattered about the town like needles in a haystack. In some towns, where the engineer has not hesitated to curtail the number of lamps, the streets can hardly be said to be electrically lighted. In one case we had under our notice lately, the lamps were placed so far apart that when standing under one lamp you would not see the next. This fault is due primarily to financial considerations, and yet when the townspeople demand that it shall be rectified endless trouble will ensue. One more lamp placed midway will then give too large a total, so that many lamp-posts now fixed will have to be moved, and in this way additional charges will be incurred. We should advise that good and permanent arrangements for the efficient lighting of a few streets should be made rather than any temporary arrangement of lamps. The other extreme has not been so much to the fore, and few towns or districts have put down large arc lighting schemes regardless of expense. Some few authorities have done so, and now are finding that, although they get a much better light in their streets, the people do not relish the increase in the rates corresponding to the increase in illumination. The result will be as before, that a reorganisation in the position of the lamps has to be made, which is both expensive and troublesome. At Hampstead, for instance, lamp-posts are being moved, and at Londonderry the Council is considering a private supply scheme to help bear the expense of the street-lighting plant. Unfortunately, the best arrangement of lighting streets economically has not yet received quite the attention it should at the hands of our leading engineers, and few facts of actual illumination have been published. The fact that the human eye accommodates itself to the lighting conditions and is incapable of gauging the actual illumination, militates against exact practice. As only relative sensations can be appreciated, it follows that very brilliant contrasts should be avoided. Hence, although frosted and corrugated glass globes absorb a good percentage of the light emitted by the lamps, they give a more pleasing general effect than clear globes. The great contrast between the brightness of the arc with the clear globe, and surrounding street, depreciates the actual illumination obtained. This objection of course vanishes, to a large extent, when high masts are used. This mast-head system is, however, not applicable to street work except in the case of wide, open spaces. A good arrangement not yet in actual

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work in England, although we understand that at Brighton the engineer has determined to adopt it, is that of suspending the lamp over the centre of the street. In this way, as described by our Munich correspondent, the lamps are situated uniformly where they are wanted, and streets are lighted more evenly than by any other method. Another advantage of this method is that the switching out of alternate lamps at midnight does not disturb the equality of the lighting. In conclusion, we would state our conviction that good and efficient lighting of the public streets can be carried out with arc lamps better than with any other illuminant, and we trust the day is not far distant when the cost of such lighting will cease to be such an unprofitable item in the balance-sheets of many electricity works.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RE STARTING DIAGRAM.

SIR,—I notice in your article of August 30 that the Fig. 6, giving a diagram of starting *single*-phase motors on a single-phase alternating-current secondary circuit arranged after the three-wire system, is marked as being a starting arrangement for *three-phase* motors. Kindly correct this little error in the next issue, and oblige—Yours, etc.,

E. KOLBEN.

84, Weinbergstrasse, Zürich, September 2, 1895.

ABERDEEN ELECTRICITY WORKS.

(Concluded from page 265.)

The arrangement for putting the worm out of gear is as follows: The spindle is mounted eccentrically in a bush, C, as will be seen in the side elevation. When this bush is turned round by the handle K, the eccentricity of the worm spindle causes it to be raised up out of gear. The brush arms can then be rotated freely by hand.

These two dynamos, when tested at Messrs. Willans and Robinson's works, gave the following efficiencies and steam consumption:

Load.	Efficiency, *i.e*, $\frac{\text{E.H.P.}}{\text{I.H.P.}}$	Water per E.H.P. hour.
Full load	84·5 per cent.	24·32
Three-quarter load	78·44 ,,	28·9
Half load	72·5 ,,	33·64
Quarter load	60·15 ,,	50·48

These trials were made non-condensing at the normal boiler pressure. After a six-hour continuous run at full load, the temperature rise on the engine end of the armature was only 48deg. F. The temperature at the other end of the armature was only 30deg. F. above that of the atmosphere, and the rise in the magnet coils was 22deg. F.

The leads from the dynamo terminals are carried across through the engine block in wrought-iron pipes, suitably curved to allow insulated cable to be pulled through. Separate pipes are provided for the leads to the shunt resistances. A resistance is provided for the shunt of each dynamo, so that the regulation of the machine under all ordinary conditions can be carried out by an alteration of the field. This resistance is made of coils of German-silver wire, and its switch has about 25 contacts. The switches for the shunt resistances are placed in front of the switchboard. The added resistance is such that when the dynamos are running at full load at normal conditions, it does not fall below two ohms for the smaller and three ohms for the larger machines. The arrangements of the engine governors allow the steady speed of the dynamos to be various within somewhat wide limits, so that at low loads the machines run slower than at high loads, in order to let the work per revolution vary no more than is absolutely necessary.

BATTERIES.

The battery-room (Fig. 3) contains two batteries, each of 65 E.P.S. K-type cells. The lead tanks contain each 16 positive plates, and are capable of discharging at 150 amperes, and the batteries have a total capacity of 1,000 ampere-hours. The regulating cells are connected by bare copper rods to the switches, which are situated in the battery-room immediately above the main switchboard. The charge and discharge switches of each battery are enclosed in airtight cases, with glass fronts, to prevent corrosion by the acid fumes. Each charge switch has 13 contacts, the discharge having 18, and are worked from handwheels on the centre slab of the switchboard in the engine-room, the switches and handwheels being geared by means of bicycle chains. Eight spare cells are provided for milking purposes and also meter testing. The room is well lighted and ventilated, and has an acid-proof asphalte floor. A large sink with a water-tap is provided, together with hose and syphons, for emptying and filling the cells.

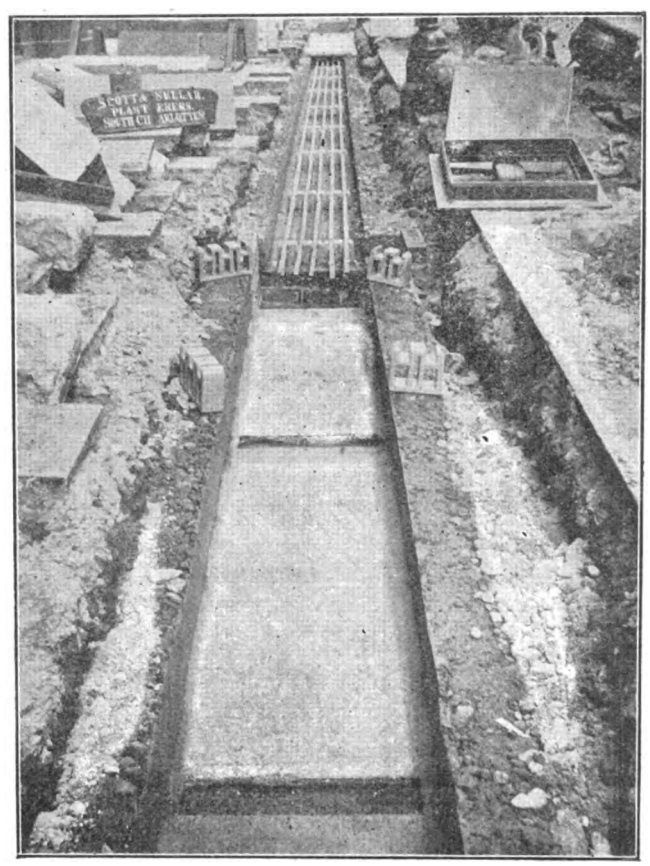

FIG. 15.—Mains in Course of Construction.

There is also a crane outside for raising carboys of acid, boxes of lead plates, etc.

SWITCHBOARD AND CONNECTIONS.

The switchboard (Fig. 12), which is of enamelled slate, was constructed by Messrs. Siemens, and is arranged in panels to enable extensions to be made at any time. The cables from the dynamos are brought along channels in the engine-room floor to the foot of the board. At the back are arranged three horizontal bars, B, the upper being the discharge bar for running direct on circuit, the middle the charge bar for the battery, and the lower being provided for testing purposes. The various dynamos and feeders are brought to vertical bars on the front of the board, and by means of plugs any dynamo or feeder can be connected to any of the horizontal bars at the back. Each dynamo is provided with an automatic cut-out, D, and ammeter. Ammeters and switches with duplex fuses, J, are placed on the feeders. By means of two-way switches, H, either of the two balancing machines can be placed on the positive or negative side of the system, or both can be placed on the

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same side. The voltmeters are of Lord Kelvin's electrostatic multicellular type, and two of his ampere-gauges are used for the largest size of dynamo. Pilot wires are brought back from each feeding point of the network, so that the attendant has practically the voltage of supply before him. The shunt resistances for the dynamos are placed in a pit under the switchboard platform, the switches being on the platform rail immediately in front of the respective dynamo ammeters and automatic cut-outs, this arrangement greatly facilitating the switching-in of the dynamos. The battery-regulating switches are worked from the switchboard by means of wheels placed concentrically on the board and provided with chain gear, the switches themselves being in the battery-room. Along the walls beside the switchboard are placed the Aron meters for the batteries and dynamos.

permanent insulation. In places where the depth of the pavement will not allow of culverts being laid, and where the circuits cross the roads, Crompton-Davis three and five way iron casing is used. The copper strip was supplied by Messrs. T. Bolton and Son, of Staffordshire. Some 40 tons of copper have been used, of sections 1in. by ·250in. and 1in. by ·200in., in lengths of 200ft. to 250ft. Armoured cables are laid in the roads in a few cases where there is not room in the sidewalks.

Most of the cables for this work were manufactured and supplied by Callender's Bitumen Telegraph and Waterproof Company, Limited, and were laid by the Corporation themselves. They consist of armoured and unarmoured cables. The unarmoured cables were insulated by means of vulcanised bitumen, put on in one solid sheath under hydraulic pressure, and finished off by means of tape, yarn,

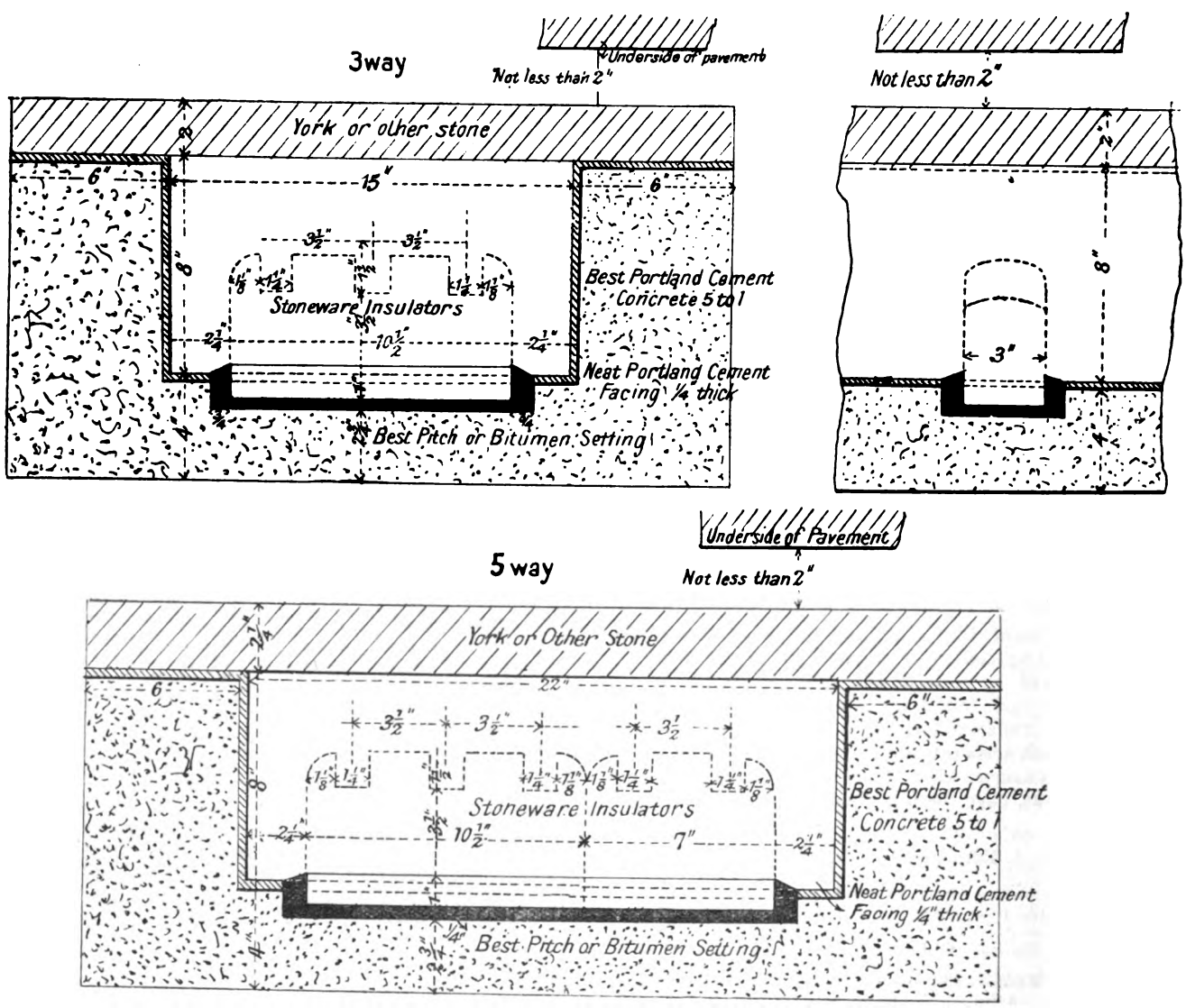

Fig. 14.—Sections of Conduits for 3-way and 5-way Mains.

Mains.

The mains, of which there are about five miles, are laid, as will be seen from the plan (Fig. 13), in the leading business streets of the city. Prof. Kennedy's system of bare strip laid in culverts is used for the network and part of the feeders. The strip is supported at intervals of 6ft. by porcelain insulators, which are fixed to the bed of the culvert by pitch. Fig. 14 shows sections of three-way and five-way culverts as actually laid on this system, and Fig. 15 is a view of the mains under course of construction. The whole of the insulators were supplied by Messrs. Doulton and Co., of Lambeth, and are of their well-known highly-vitrified stoneware. Between three and four thousand insulators have been used. They are of similar pattern to those that have been supplied by this firm for the Oldham, Belfast, Sunderland, and Edinburgh schemes, where they have given every satisfaction. The material and design of these insulators are both such as to ensure high and

and braid. The armoured cables were insulated by means of a dielectric of vulcanised bitumen, then lead sheathed, yarned, and armoured by two steel tapes, finally served over all with a double layer of jute yarn thoroughly impregnated with bitumen. These cables have now been in work for some considerable time, and the orders for the extensions now being made in Aberdeen have also been placed with the Callender Company.

Sections of cable laid.	Quantities of cable laid.
Unarmoured.	Unarmoured.
·7 square inch section	213 yards
·6 ,, ,, ,,	240 ,,
·4 ,, ,, ,,	1,225 ,,
·2 ,, ,, ,,	120 ,,
·5 ,, ,, ,,	6,440 ,,
Armoured.	Armoured.
·25 square inch section	400 yards
·5 ,, ,, ,,	300 ,,
·6 ,, ,, ,,	433 ,,

The British Insulated Wire Company also supplied some

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REVENUE AND EXPENDITURE ACCOUNT.

Dr.	10 months ending Dec. 31, 1894. £ s. d.	12 months ending July 31, 1895. £ s. d.	Cr.	10 months ending Dec. 31, 1894. £ s. d.	12 months ending July 31, 1895. £ s. d.
Sale of current, per meter	1,679 11 1	2,704 17 8	Fuel	189 1 1	242 8 3
Public lighting	113 16 1	154 12 8	Oil, waste, water, and engine-room stores	60 10 7	64 13 5
Rental of meters	56 13 2	115 13 0	Wages at generating station	146 12 4	233 5 4
			Repairs on buildings	1 11 7	5 17 0
			Repairs on plant	2 12 7	38 15 7
			Main and service repairs	13 13 10	26 3 5
			Attending and maintaining public lamps to May 16, 1894	15 7 3	0 12 0
			Feu-duty and taxes	102 19 8	125 3 8
			Management	50 0 0	79 3 4
			Salaries of engineers	252 6 0	244 3 11
			General establishment charges	21 19 5	34 13 11
			Stationery and printing	9 16 3	41 13 11
			Bad debts	—	2 19 11
			Insurance	12 9 6	17 5 6
			Inspector's wages	0 9 5	2 6 4
			Balance carried to net revenue account	970 10 10	1,815 17 10
	£1,850 0 4	£2,975 3 4		£1,850 0 4	£2,975 3 4

NET REVENUE ACCOUNT.

Dr.	£ s. d.	£ s. d.	Cr.	£ s. d.	£ s. d.
Balance brought from revenue and expenditure account	970 10 10	1,815 17 10	Interest on mortgage and other loans	523 5 6	656 2 10
Balance chargeable against the gas department — carried to general balance account	217 15 6	109 3 1	Depreciation for 10 months on amount expended on capital account, at February 28, 1894:		
			Buildings, at 1 per cent.	28 2 6	52 11 5
			Machinery, at 5 per cent.	178 14 2	375 17 3
			Accumulators, at 5 per cent.	23 15 10	50 17 10
			Mains and services, at 1½ per cent.	101 9 2	179 1 5
			Electrical instruments, at 2½ percent.	23 19 2	35 9 6
			Meters, at 5 per cent.	12 6 8	36 3 6
			Sinking fund, at 2 per cent.	296 13 4	538 17 2
	£1,188 6 4	£1,925 0 11		£1,188 6 4	£1,925 0 11
Amount received from gas department, being loss to December 31, 1894		217 15 6	Balance at debit July 31, 1894		292 6 10
Balance carried to next year's account		183 14 5	Loss for year to July 31, 1895		109 3 1
		£401 9 11			£401 9 11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Period.	Number of units generated.	Units sold.			Units used in works.	Units accounted for.	Loss in distribution and unaccounted for.	Number of public lamps.
		Public lamps.	Private consumers.	Total sold.				
Ten months ending Dec. 31, 1894	71,921	6 169	58,843	65,012	1.114	66,126	5,795	10
Twelve months ending July 31, 1895.	118,193	8,163	98,122	106,285	1,570	107,855	10,338	10

of their paper-covered cables for street work. The section of the whole of the network, including both strip and cable, is ·2 square inch.

Demand for Light.

Since the opening of the station in February, 1895, the demand for light has rapidly increased. The increase in the equivalent number of 8-c.p. lamps connected during the last year is as follows:

Date.	Lamps connected.
August 1, 1894	4 348
September 1, 1894	4,964
October 1, 1894	6 470
November 1, 1894	7,389
December 1, 1894	8 010
January 1, 1895	8,440
February 1, 1895	8 660
March 1, 1895	9,067
April 1, 1895	9,350
May 1, 1895	9 560
June 1, 1895	9,624
July 1, 1895	9,827
August 1, 1895	10,327
September 1, 1895	10,900

Applications for the supply of current are coming in steadily. Many of the principal buildings are already coupled up, or are at the present time being wired. These include the Town House and Municipal Buildings, the new Police Offices, the Incorporated Trades' Hall, Robert Gordon's College and Gray's School of Art, and Marischal College. The latter fine building, at present being wired by Messrs. Shirras, Laing, and Co., of Aberdeen, will be a very fine installation. The picture gallery alone will be lighted by 170 16-c.p. lamps studded in panels over the ceiling. It is expected a very fine effect will be thus obtained; this also is a feature of the lighting of the large banqueting-hall, which has 206 16-c.p. lamps. The total number of lamps coupled to the mains is over 11,000 8-c.p.

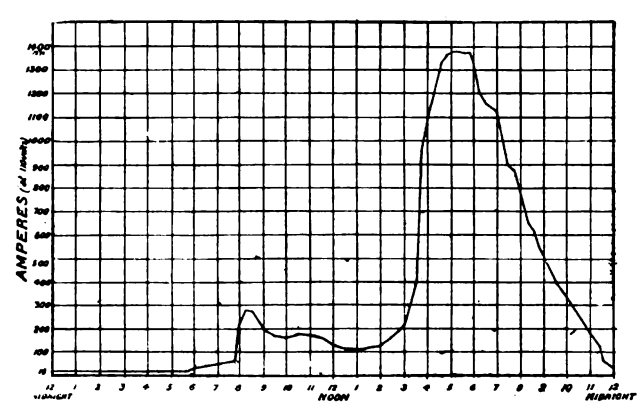

Fig. 16.—Load Diagram, Dec. 24th, 1894.

The load diagram (Fig. 16), reproduced, was taken on December 24 last, and shows the highest load yet attained—viz., 1,370 amperes at 110 volts. The number of 8-c.p.

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lamps on circuit at that time was only 8,440. The area supplied is composed almost entirely of shops and offices, most of which close between the hours of 5 and 8 p.m., thus causing the large peak observed. The extension of the area of supply into the residential district will considerably alter this, and will also produce a larger load between the hours of midnight and 8 a.m.

A showroom of electric motors is now being organised by the engineer to induce the users of power to employ motors for their work, and thus to increase the day load.

We give herewith a copy of the accounts for year ending July 31, 1895, and also for the first 10 months after the station started working. Although with the system of book-keeping adopted a total loss of £401. 9s. 10d. is shown for the whole period, we consider that the station is for all practical purposes a financial success, and that such should be the case so soon after starting is very creditable to all concerned. While admitting that machinery and buildings do depreciate, we consider that when a station is charged with the repayment of loan in the shape of a sinking fund, and the machinery is kept in repair, that the depreciation items are doubly charged. The facts of the case before us are as follows: For the year the station showed a gross profit of £1,815. 17s. 10d, of which some £1,195 was required for interest and repayment of loan. This practically amounts to a net profit of £620. 17s. 10d. on the year's working. £720 is a substantial amount to write off a capital of under £25,000, and at this rate in a few years the Aberdeen Electrical Department will be very well off as regards capital charges. The improvement in the cost per unit during the two periods is very marked. The total cost of generation has been reduced from 2·94d. per unit to 2·35d. per unit. The cost of fuel now stands at the low figure of 0·49d. per unit generated, and at 0·54d. per unit sold. These figures will compare well with those of any station in the kingdom.

The efficiency of distribution is also good, as it stands at 91·5 per cent. for the current year, in which only 10,338 units were unaccounted for out of some 118,193 units generated.

The present Gas and Electric Lighting Committee consists of the following gentlemen, and they are to be congratulated on the results of the year's working: Councillor Johnston (convener), Lord Provost Stewart, Treasurer Bisset, Councillors Fleming, Glass, Gray, Mundie, Sangster, Skinner, and Young.

A feature of the station working is the complete system of book-keeping and reports adopted. Besides a very complete and full weekly report, and the usual log sheets, there is a daily report book kept, which is made up every morning by the assistant responsible for the run the night before. This gives hours of running, the number of units generated for the day, full particulars of the charge and discharge of the batteries, the cost of generating per unit under the headings of "Fuel," "Water," and the various engine-room stores, each item being worked out separately. The pounds of water evaporated per pound of fuel, together with the names of the drivers, stokers, and switchboard attendants on the shift are also given. By this means the chief engineer is able to at once check and rectify any irregularity in the working of the station almost as soon as it occurs.

NEW CATALOGUE.

Messrs. Johnson and Phillips, of Charlton, have just issued a new catalogue of cable-making and wire-covering machinery, which is, as far as we know, the only publication dealing so fully with this class of machinery. It differs, however, in one respect from all previous catalogues which have passed through our hands in that the price columns are everywhere left blank. We welcome this publication, therefore, as a descriptive list of the machines for special work, and feel as much in the dark as ever as to the cost of the cable-making machines. The illustrations are excellent, and we are able to reproduce three typical examples.

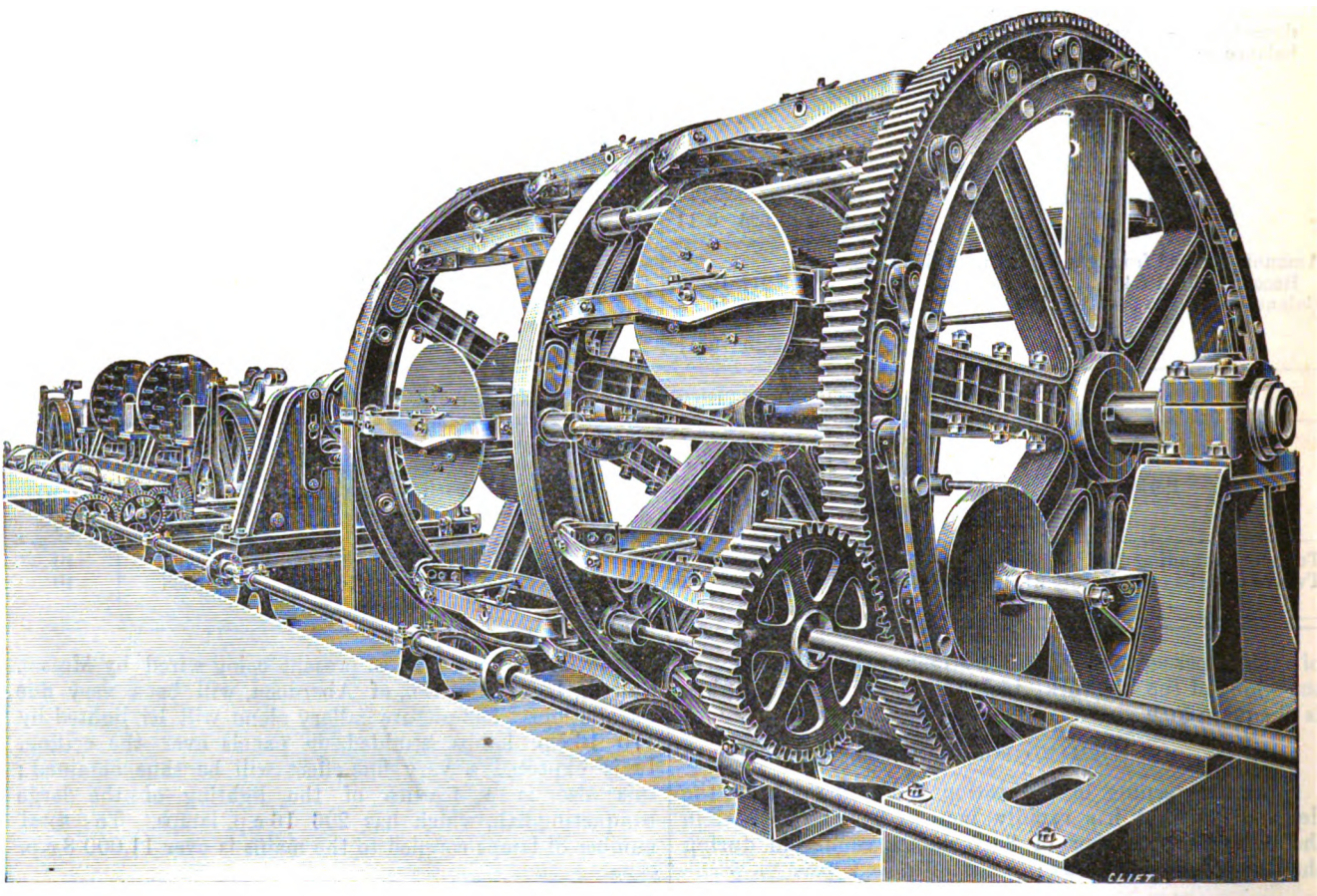

FIG. 1.—Submarine Cable Sheathing Machine.

It seldom falls to the lot of one firm to be both manufacturers and users of the same machines, but when it does, as in the present case, the experience gained by the actual working of the machines will naturally result in the best design to fulfil the requirements of the work to be performed; and in this connection it will be noticed that the particulars of the output of the various machines are given, a departure which is a good feature.

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Fig. 1 is a sheathing machine with 18 bobbins, 36in. diameter, for sheathing "shore-end" cables with iron or steel wires, and serving them with protective coverings of yarns, tapes, and compounds at one operation. The complete machine includes engine and counter-shafting for driving the various parts, two draw gears, two yarn-serving discs, two taping heads, three compound tanks, and one set of bobbins, but machines can be supplied with only one draw gear and with apparatus for any number of servings. The whole machine takes up a space 88ft. long by 16ft. broad, and each of the 18 bobbins can hold 24cwt. of iron wire. A separate engine is provided for driving the machine, but it is not shown in the illustration; it is fixed at this end of the machine, and is connected by means of gear wheels to the shaft shown in the front part of the engraving. The bobbins are 3ft. in diameter, and each one is provided with a steel friction strap to regulate the tension on the wire as it is being drawn off. They are arranged in two bays of nine each, and are supported in massive flyers, composed of wrought iron and steel, which are carried in three large cast-iron discs. These discs are 11ft. 9in. diameter, and they are made in halves for convenience in transit, and held together with bolts and wrought-iron hoops. The bobbins are kept in the horizontal position during the working of the machine—thus preventing twist in the wires themselves—by means of an eccentric ring, which is hung from cranks attached to the ends of the flyers. This machine is said to be the largest yet made for the above purpose.

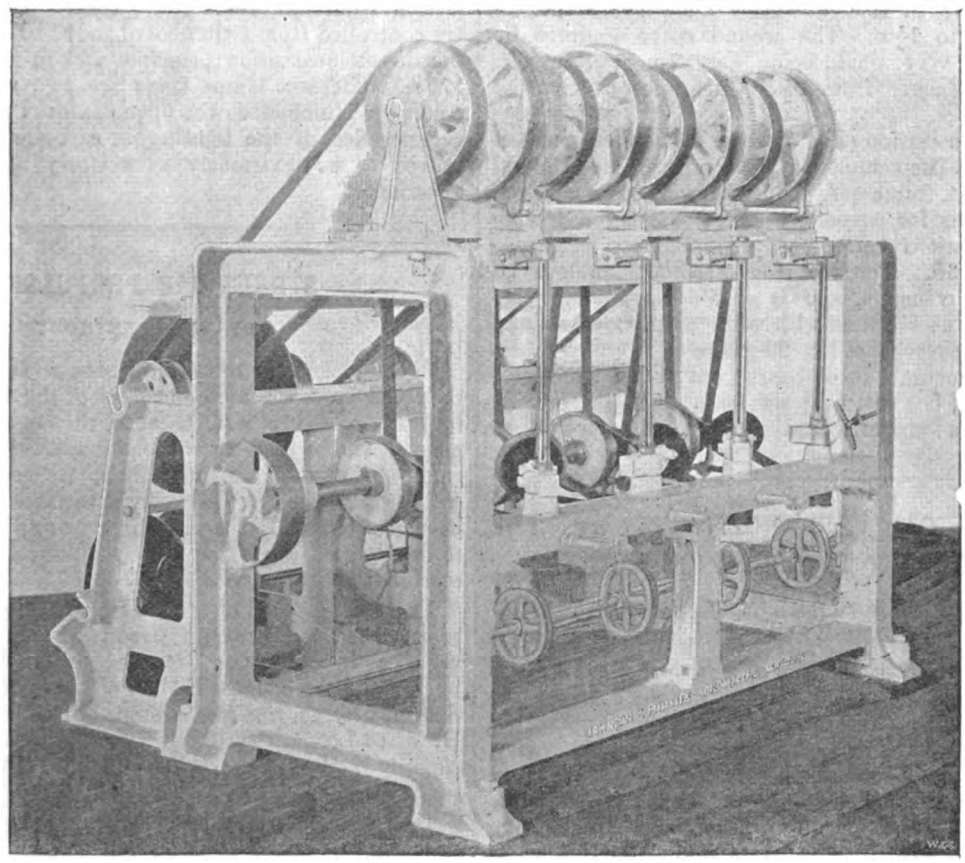

FIG. 2.—Vertical Multiple Rubber Lapping Machine.

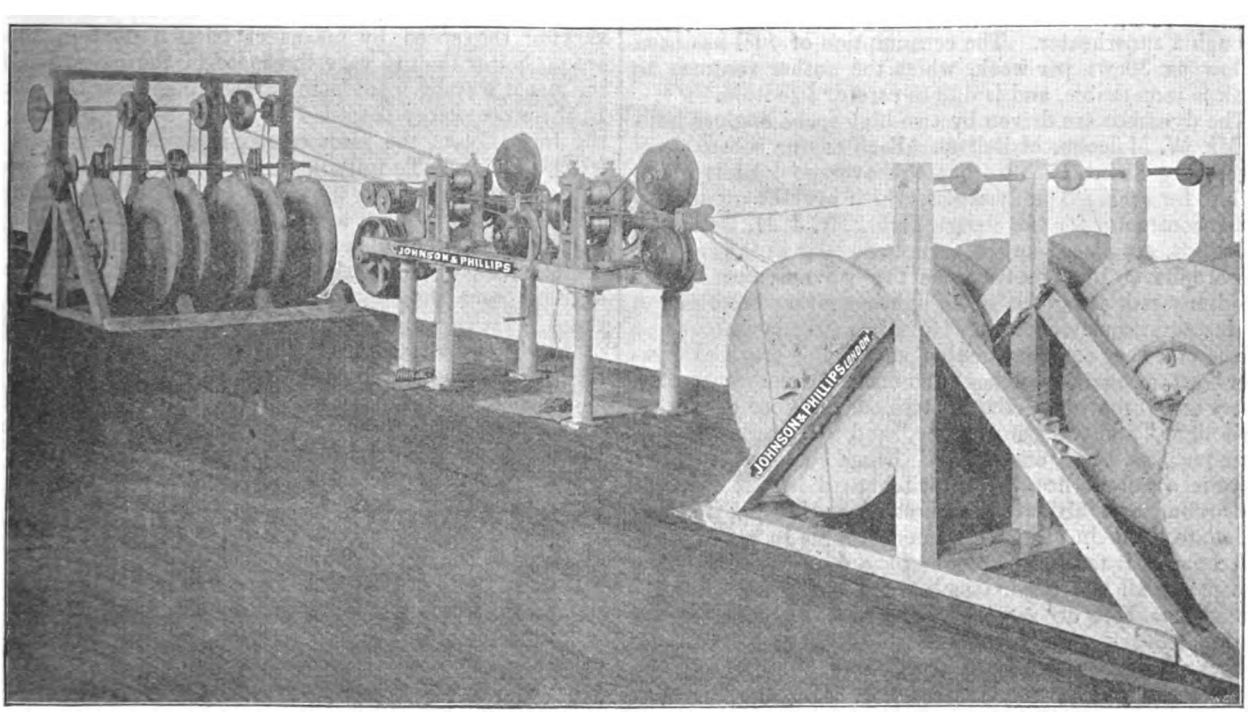

FIG. 3.—Complete Longitudinal Rubber Covering Plant.

Fig. 2 is an illustration of a multiple vertical rubber-

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lapping machines for electric light wires. These machines are designed for covering the single wire or stranded copper conductors with pure rubber tape, and they are suitable for strands up to $\frac{3}{8}$in. diameter. Each machine has four heads, which can be stopped independently of each other, and is provided with change wheels for varying the lay from about $\frac{1}{4}$in. to $1\frac{1}{4}$in. The ground space occupied by the machine is very small, being only 7ft. 6in. by 6ft. Each head will cover from $2\frac{1}{2}$ to $3\frac{1}{2}$ miles of wire per working day.

The other illustration (Fig. 3) is of a complete rubber-covering plant. The complete plant comprises longitudinal covering machine, frame and drums for wire to be covered, frame and drums for covered wires, with friction driving gear and automatic traverse gear. The diameter of drums for the wires is 3ft. The covering machine combines all the latest improvements, and is capable of covering six wires or strands at one time with white or black compound rubber. It will cover from No. 20 gauge wires up to cables 1in. outside diameter. It, of course, only takes one cable of this diameter, but will take six leads up to $\frac{3}{8}$in. outside diameter, and a proportionate number of intermediate sizes.

THE ELECTRICAL ARRANGEMENTS AT THE BELFAST FIRE STATION.*

BY JAMES MUNCE, A.M.I.C.E., M.S.I., ASSISTANT CITY SURVEYOR.

The system of electric bells is so arranged that the duty man can call any individual, or, by turning a lever, the whole staff at once; a sick man or one off duty can be left undisturbed. The station is lighted entirely by electricity, the current being generated on the premises. A very compact Lancashire boiler, made by Galloways, of Manchester, supplies steam not only to the engines for driving the dynamos, but also to a separate engine for the work-shops, for boiling hot water in the cistern which supplies each of the 25 houses, laundry, single men's quarters and superintendent's house, and steam to the heating coils in duty-room, engine-house, gymnasium, etc. It is kept at about 40lb. pressure during the day, and at 80lb. whilst the electric light is turned on to the whole station—*i.e.*, to 11 p.m. The exhaust steam is used for heating the feed water which is pumped into the boiler by a Worthington pump, through a superheater. The consumption of fuel has been as low as 30cwt. per week, which the author ventures to think is remarkable, and is due to careful attention.

The dynamos are driven by two high-speed engines built by Mr. W. Malcolm, of Belfast. Each engine is capable of developing about 18 h.p., but the average load is about 10 h.p. for each. The dynamos, which are the production of the contractor for the electric light, Mr. J. H. Greenhill, of Belfast, are placed on the same bed-plates as the engines, and are driven by belts from the respective flywheels. To avoid any risk of failure in the lighting, either machine can be instantaneously connected to any particular circuit by means of a very complete double-pole, double-break "throw-over" set of main switches, also made by the contractor. There are three main circuits, termed the "ordinary," the "all-night," and the "emergency," and these terms explain their purpose, the "emergency" being switched on when there is a call of fire. The switchboard is placed in the duty-room, and although at first sight it appears very elaborate, it is in reality extremely simple to manipulate, and renders it totally impossible for a mistake to be made. It contains all the Corporation's telephone wires, the direct fire alarms, bells to each apartment and dwelling in the station, electric light switches, speaking-tubes, etc., also gauges showing the pressure of the town water supply and the electric light volts and amperes. In short, the duty man at the switchboard has control of the lights, bells, and telephones of the whole establishment and the out-stations as well. The ordinary lights are switched out at 11 p.m., but there is an additional switch for each lamp in the dwelling-houses and in other sections, by which any lamps not required may be cut off. When the fire alarm rings, the "emergency" switch is operated, and instantaneously the special lights in the fire-engine room, stables, single men's quarters, and one light in each of the married men's houses are illuminated, so that no delay occurs in any section from want of light. These "emergency" lights are controlled from switchboard only. The current is on the direct low-tension principle, and in addition to about 170 incandescent lamps there are two very powerful arc lamps for illuminating the open spaces of the station. The general effect of the lighting is extremely fine, and it has proved to be extremely satisfactory after two winters' experience.

* Extract from a "Description of the Headquarters of the Belfast Fire Brigade," read at the Londonderry meeting of the Association of Municipal and County Engineers.

STREET-CAR PROPULSION.

BY W. A. ANTHONY.

In the operation of electric cars, it is well understood that benefits of the high efficiency of the electric motor are in great measure lost, because the motor does not, in general, run at its most efficient speed. The desirability of running the motor continuously at its best speed, and controlling the speed of the car by a variable gearing, has long been recognised, and numerous attempts have been made to devise such a gearing that should stand the wear and tear of street-car service.

The ideal method of obtainable variable speed would be to drive the motor from a circuit whose voltage could be varied as in the system proposed by H. Ward Leonard, or by varying the counter E M.F. of the motor as was done by Sprague, by varying the strength of the field magnets. The H. Ward Leonard system is a costly outfit, and it is impossible by varying the strength of field to obtain the necessary range of speed.

It was not my object to discuss here the electrical methods of speed control, but rather to consider the problem of obtaining a variable speed on the car from a constant-speed motor. Any system of gearing for varying the speed must, to meet with favour, be simple, durable, and certain in action, and must operate without waste of power. It should also vary the speed from zero to the maximum by a continuous gradation. Many of the methods that have been proposed are faulty because of their inefficiency. Of this class are all the plans for varying the speed by means of friction devices. These are no better than to vary the speed of the motor itself in the usual way by introducing a resistance into the circuit. In this case energy is wasted in heating the resistance. In the former case, the same energy is wasted in heating the friction clutch. To fully understand this, it is only necessary to consider that in starting a car and bringing it up to speed, at least as great a "torque" is required as to maintain its speed after full speed is reached. During all the time, therefore, that the car is coming up to speed, the motor is exerting more than its normal force while running at full speed. It is therefore delivering more than its rated power, of which only a fraction is used in propelling the car, the remainder being consumed in heating the clutch.

Suppose, for instance, the car were running at only one-fourth the speed it will have acquired when the clutch ceases to slip, one-fourth of the energy delivered by the motor is then imparted to the car, and three-fourths to the friction clutch.

A liquid transmission has been tried where a pump is attached to the electric motor and a liquid motor to the car axle, the varying speed being obtained by allowing part of the liquid put in motion by the pump to pass by the liquid motor through a valve by which its amount could be controlled. A moment's reflection will show that this is only a sort of liquid friction clutch, and that it is open to the same objection. It is plain that the pressure at the by-pass valve must be the same as at the motor, and that the work done at each must be proportional to the amount of liquid passing through it. Where the car is being propelled at one-fourth speed, one fourth of the work done by the electric motor is expended upon the car axle, and three-fourths upon the liquid as it is forced through the by-pass valve. This latter simply goes

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to heat up the liquid, and is wasted energy. It is plain that there is nothing gained by any such device. With the motors as they are now used, themselves varying in speed, the electrical energy at slow speed is expended partly upon the motor usefully and partly in the starting rheostat wastefully. With the motor and variable gear, as has been described, the motion of the constant-speed motor being transmitted to the car axle through a friction clutch or any equivalent, the electric energy is all expended upon the motor, but the energy of the motor is only partially transmitted to the car axle except at full speed.

Any device to fulfil the requirement must take from the line, barring the inevitable losses of transformation, only the power applied to the car axle. As the motor is only efficient when running at full speed, the variation of speed must be obtained by a variable gearing that does not consume power except in transmission. The difficulty has been to find such a gearing that would stand the rough usage of street-railway service. As an example of the kind of gearing required, though not as a practical solution of the problem, the motion of the motor might be transmitted to the axle through a pair of cones, the variable speed being obtained by shifting a belt.

A few years ago a liquid transmitter was proposed in which, as I remember it, a pump was placed upon the shaft of the electric motor and three liquid motors of different capacities were placed upon the car axle. These motors could be used singly or in pairs, or all three together, giving seven different speeds. This plan is entirely correct in theory; it is only a question how it would work out in practice. It has the disadvantage that the speed is varied by steps and not continuously. In another device, recently proposed, four reciprocating pumps are arranged radially at angles of 90deg. with each other, and actuated from the same crank upon the shaft of the electric motor. This crank has a variable throw, adjustable while in motion, from 1½in. on one side to 1½in. on the other side of the centre. When the throw is greatest, the pumps deliver the largest quantity of liquid and impart to the car axle the highest speed. When the crank pin is at the centre, no liquid is delivered and the car stops. With the crank pin transferred to the opposite side of the centre, the motion of the car is reversed. The speed may therefore be varied from full speed in one direction to full speed in the opposite direction by a continuous gradation, the electric motor continuing to run in one direction at full speed. This device is theoretically an ideal arrangement. It uses just the power needed at all speeds; it provides for changes of speed through all possible gradations from zero to the maximum, and the same operation carried far enough reverses the car. Moreover, when the car is at full speed, if the strokes be shortened, the speed of the electric motor is increased, and it becomes a generator, restoring current to the line, and acting as a very efficient brake to reduce the speed of the car.

If the crank pin be brought to the centre the pistons are held stationary, no liquid can pass through the pump, consequently the car axle cannot revolve and the car must be brought to rest. The motorman controls the entire movement of the car, starting, applying the brake, and stopping, by one handle, and by a means which makes the control absolute. He runs at any speed he likes within the limits for which the machinery is constructed; he diminishes and increases the speed at pleasure; having always a definite speed for each position of the controlling handle, he brings the car quickly to a full stop by simply bringing the handle to the zero position. Indeed so definite might be the speed of a high-efficiency shunt motor or a polyphase induction motor, that the dial of the controlling handle might be marked in miles per hour from zero up.

I say this is theoretically an ideal arrangement. Experiment must decide how it will work in practice. One difficulty occurs to me. Since there are four cylinders there is a constant pressure, and work constantly being done at all positions of the crank pin. To move the crank pin out from the centre must therefore require considerable force. An idea of the amount of force may be obtained by considering that if the electric motor were stopped with the crank pin at the centre, to move it outward would displace the pistons, force the liquid round through the liquid motors, and turn the car axle. The same work must be done to move the crank pin outward when the motor is in motion. Can this work be done by the motorman as rapidly as it would need to be done to control the car? Will a loose crank pin, controlled by a rack and pinion, stand the service that it must perform? Experience will tell.

LEGAL INTELLIGENCE.

DUBLIN AND BLACKROCK ELECTRIC TRAMWAY.

On September 3, before Mr. Justice Murphy, sitting as Vacation Judge, to hear motions for the Common-Law Divisions, in the case of the Pembroke Township Commissioners v. the Dublin Southern District Tramway Company,

Mr. Piers White, Q.C., with whom was Mr. T. C. Drury (instructed by Messrs. D. and T. Fitzgerald), said he appeared on behalf of the plaintiffs to apply for an injunction to restrain the defendant company from breaking up or excavating the roadway between the tram rails and the footpath in the township of Pembroke. Counsel explained that on the previous day the defendants, in connection with the laying down of their new electric tramway, commenced to break up the road close to the boundary of the Pembroke and Blackrock townships, in the face of the protest of the plaintiffs, in contravention of an understanding arrived at when the defendants were seeking powers in Parliament for the purpose of using electricity on their tramway, and in contravention of Section 14 of their Act, which gave them power to work the tramway by overhead wires only, whereas, as now alleged, they were about to sink cables in the roadway for the purpose of conducting the electric current. A letter, counsel said, had been received from the tramway company asking that the application should be allowed to stand to give them an opportunity of filing affidavits, an undertaking being given that the work objected to would not be proceeded with in the meantime.

Mr. Justice Murphy allowed the application to stand for a week.

BLACKPOOL CORPORATION.

The following is an abridged statement of the electric lighting accounts of the Corporation of Blackpool for the year ended March 25, 1895:

ELECTRICITY GENERATED.

Sold by meter	155,333
Public lamps	61,752
Used on works	6,334
	223,419
Magnetising, condenser, and main losses	54,008
Total apparent units generated	277,427

EXPENDITURE.

	£ s. d.	£ s. d.
Generation—Coal and coke, including unloading, terminal charges, shunting, repairs to siding, and siding rent	1,083 5 10½	
Oil and waste and sundry stores	345 6 4½	
Water	164 3 0	
Wages—stokers, drivers, electricians	916 15 9	
Repairs and maintenance of buildings, boilers, engines, dynamos, switchboard, and crane	161 5 6½	
		2,670 16 6½
Distribution — repairs to transformers, mains, meters, etc.		20 15 11
General—Salaries of engineer, clerks, treasurer; books, printing, stationery, and advertising	479 12 4	
Rent of land, rates, etc.	154 10 2	
Insurance, travelling expenses, testing new plant, inscription plate, postages, telegrams, refreshments, etc.	116 17 4½	
		750 19 10½
Special—cost of foundations, etc., for temporary plant, cable, etc.		76 6 3
Public lamps—attendance, repairs, carbons, painting lamp-posts, altering lamps to suit rectified current, etc.		357 15 10½
Interest	1,165 7 11	
Sinking fund	716 14 3	
		1,882 2 1
		5,758 16 6½
Less receipts		5,480 19 5½
Leaving net loss on year's working		£277 17 1

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Receipts.	£	s.	d.
Current per meter, etc., less discounts	3,250	18	7
Meter rentals, etc.	98	9	10
Public lighting—Current £1,479 1 10			
Carbons, attendance, etc. 357 15 10½			
Interest and sinking fund 267 9 5			
	2,104	7	1½
Premiums from students	21	9	7
Sale of ashes	5	14	4
	£5,480	19	5½

Capital Account at March 25, 1895.

	£	s.	d.
Buildings, foundations, offices, etc.	9,250	3	0
Machinery	15 805	8	2
Mains	8,941	4	5
Transformers, meters, and instruments	2,954	8	1½
Public lamps	3,749	15	7
Sundry expenses	780	15	10
	£41,481	15	1½

COMPANIES' MEETINGS AND REPORTS.

MILNER PORTABLE ELECTRIC BATTERY SYNDICATE, LIMITED.

The statutory meeting of this Company was held on Monday in Birmingham, Mr. Hyman Levetus presiding.

The **Chairman** explained that the Company was a private limited one—all the shares having been subscribed for. In regard to the construction of their battery, they had been told by experts that the difficulties of polarisation were insuperable, and that the cost of zinc was too prohibitive, but the impossible had been overcome. They did not use zinc at all, and as for polarisation, they did without it absolutely by means of the automatic circulatory system. The light would not exceed a cost of 6d. per Board of Trade unit The traction would cost 4d. per horse-power per hour—that is to say, they could have the work of a horse done for 4d. per hour. When this electric horse was not at work it cost nothing, and when charged it would run for 10 hours without refreshment. An invention such as this would do away with the cry for light railways. Every farmer could have his own produce wagon and take it along the roads at the highest rate of speed allowed by the authorities, at a cost of 4d. per hour per horse load. A battery could be supplied large enough to light a cathedral or small enough to carry in the hand as a bedroom candle. The Company hoped soon to exhibit a horseless carriage and electric lighting with Milner batteries. Meanwhile arrangements were being made to secure patent rights in 15 countries.

ELECTRIC CONSTRUCTION COMPANY, LIMITED.

Directors: Sir Daniel Cooper, Bart., G.C.M.G., chairman; James William Barclay, deputy-chairman; Philip Edward Beachcroft; John Irving Courtenay; Sir Henry C. Mance, C.I.E.; James Pender, M.P. Manager: A. B. Blackburn, M.I.C.E. Secretary: James Gray.

Report of the directors to be submitted to the shareholders at the second annual general meeting of the Electric Construction Company, Limited, to be held on Thursday, September 12, 1895, at Winchester House, Old Broad-street, E.C., at 2 30 p.m.:

The accounts for the year ending June 30, 1895, submitted herewith, show a gross profit of £46,690. 15s. 2d., including £2,260. 5s. 7d. brought forward from last year. Deducting from this amount interest, outlays on maintenance of buildings, plant, and patents, general expenses, and £5,000 for depreciation, the result is a net profit of £12,091. 10s. 3d., whereof the directors recommend that £1,956 14s 5d. be applied in payment of the dividend of 7 per cent. on the preference shares, and the balance of £10,134. 15s. 10d. carried forward to the credit of next account. The profit and loss account shows a considerable reduction of general expenditure, and, notwithstanding the keen competition prevalent, a substantial increase of manufacturing profit. Several important electrical installations have been successfully completed during the year, the production at Bushbury has increased, and the quality of the machinery and plant manufactured has been fully maintained. The directors have pleasure in reporting that the works are fully employed on orders at prices somewhat in advance of those obtainable last year, that the plant and number of the workmen have been increased, and that they are well satisfied with the efficiency and zeal of the staff and employés of the Company. Among the works in progress may be mentioned the important electric lighting installation at Clerkenwell and the electrical equipment of the Hartlepool tramways. It is confidently expected that the substitution at Hartlepool of electric traction for the steam power formerly used will prove that tramways heretofore worked by horse or steam power unremuneratively may be judiciously adapted for electric traction and yield a satisfactory return on the necessary outlay. Such a result cannot fail to give a great impetus to the development of electric traction in various directions. The directors who retire by rotation at the general meeting are Messrs. James W. Barclay and J. Irving Courtenay. They are eligible for re-election. Messrs. James Meston and Co., the auditors for the past year, offer themselves for re-election.

Profit and Loss Account, Year ending June 30, 1895.

Dr.	£	s.	d.
Interest on loans and debentures paid and accrued	13,223	17	5
Salaries to staff in head office and works	8,149	19	4
Rent, rates, and taxes at head office and works	1,043	18	4
Insurances	195	3	10
Advertising	800	10	10
Travelling expenses	721	7	2
Patent fees and royalties	483	4	2
Law charges	101	11	8
Printing and stationery, postages and telegrams	651	7	4
Commissions and agency charges	130	1	6
General expenses, bank charges, stamps, etc.	889	0	9
Fees and expenses of trustees under first and second mortgages	210	5	6
Auditors' fee	120	0	0
Directors' fees	1,500	0	0
Maintenance of plant and buildings	1,378	17	1
Depreciation account	5,000	0	0
	£34,599	4	11
Net profit	12,091	10	3
	£46,690	15	2

Cr.	£	s.	d.
Amount brought forward from last year	2,260	5	7
Gross profit—on manufacturing and contracting	31,814	12	7
Rents, profit on maintenance contracts, premiums from pupils and sundry profits	6,701	4	10
Interest and dividends on debentures and shares of other companies	5,890	13	8
Transfer and registration fees	23	18	6
	£46,690	15	2

Balance-sheet, June 30, 1895.

Capital and Liabilities.	£	s.	d.
Capital authorised—150,000 ordinary shares of £2 each	300,000	0	0
50,000 cumulative 7 per cent. preference shares of £2 each	100,000	0	0
	400,000	0	0
Capital issued - 110,000 ordinary shares of £2 each, fully paid £220,000 0 0			
13,145 cumulative 7 per cent. preference shares of £2 each, fully paid 26,290 0 0			
3,198 ditto, £1. 10s. paid up, £4,797; add calls prepaid, £744. 10s.—£5,541. 10s.; less calls in arrear, £68. 5s. 5,473 5 0			
	251,763	5	0
Debentures issued—first mortgage 6 per cent. debenture bonds, authorised issue, £150,000 (246 ditto, issued and deposited as security, £24,600) 125,400 0 0			
Second mortgage 6 per cent debenture bonds, authorised issue, £100,000; current at July 1, 1894, £46,900; less drawn and paid off during year, £2,210 44,690 0 0			
	170,090	0	0
Loans (secured by deposit of £24,600 first mortgage debentures, and of shares and debentures in other companies)	110,000	0	0
Sundry creditors 20,136 7 7			
Debenture interest accrued 4,850 8 6			
	24,986	16	1
Bills payable	1,164	12	5
Depreciation account — Brought forward 3,000 0 0			
Credited for year 1894-5 5,000 0 0			
	8,000	0	0
Profit and loss account—net profit	12,091	10	3
	£578,096	3	9

Assets.	£	s.	d.
Freehold and leasehold land and buildings at Bushbury (Wolverhampton) and Millwall; plant, machinery, tools, and patterns at works; patents and goodwill, as per last account	304,386	15	0
Additions to plant and furniture during the year	1,725	2	8
Additions to buildings	214	19	10
	£306,326	17	6
Less property at Commercial-road, Wolverhampton, sold	2,351	1	11
	303,975	15	7
*Shares and debentures of other companies	135,670	9	10
Sundry debtors (after providing for bad and doubtful debts)	86,464	3	1
Trustees of first mortgage debentures—price of property sold	2,500	0	0
Bills receivable	304	1	0
Work and contracts in progress—cost	18,134	4	7

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Stock—finished goods and materials on hand—cost	22,670	15	6
Cash at bankers and in hand	8,376	14	2
	£578,096	3	9

*Note.—There is a contingent liability in respect of amounts uncalled on certain of these shares.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Alexandria.—The municipal authorities of Alexandria, Egypt, invite applications by October 1, 1895 for the concession of the tramway lines from St. Catherine Place, through the outer boulevards, to the projected abattoirs at Mex, with a branch line. Security £E1,000.

Paris.—The Direction Générale des Postes et Télégraphes invite tenders by September 10 for the supply of 100 tons of copper wire and 24,000 tinned copper brackets; and by September 16 for making two air-conduits for the pneumatic telegraph service. The Cahier des Charges may be seen at rue de Grenelle, No. 103 (division du matériel et de l'exploitation électrique, 3ME bureau).

Braila.—The Municipal Authorities of Braila, Roumania, invite tenders by October 2 for the construction and working of a system of electric tramways in the city. Provisional security, 10,000f This contract was originally fixed for July 29. Tenders are further invited by the Municipal Authorities of Braila for the lighting of the city by electricity or by electricity and gas Provisional security 10,000f.

London, W.C.—Tenders are required for carrying out the work required in supplying and fixing wires, cables, and fittings for the installation of the electric light at their Board-room and offices, 57, Broad-street, W.C., for the Guardians of St Giles and Bloomsbury. Printed forms of tender can be obtained at the offices of Mr. James Appleton, clerk. where they must be delivered, sealed and endorsed "Tender for Electric Lighting," at or before 10 a.m. on September 10.

Chepping Wycombe (Bucks.).—The Urban Sanitary Authority for this borough are prepared to receive tenders from public companies for working the electric order obtained by them within the borough for a term of years and upon approved conditions. Tenders are to be delivered by noon on October 14 next, at the office of the town clerk, High Wycombe, where a copy of the electric order may be seen and further particulars obtained. The Authority do not bind themselves to accept any tender.

Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

Oldham.—The Baths Committee of the Oldham Corporation are prepared to receive tenders for supplying and fixing wires, fittings, etc, for lighting by electricity a portion of the Central Baths, Oldham. Specifications can be obtained from Mr S Willmott Newington, borough electrical engineer, Gas street, Oldham, on payment of 10s. 6d., which will be refunded on the return of the specification accompanied with a *bonâ fide* tender. Tenders, endorsed "Tender for Wiring," must be sent to the office of the town clerk, Town Hall, Oldham, before noon on September 11.

Shoreditch.—The Shoreditch Vestry invite tenders for—Section A—insulated electric mains; Section B—conduits and drawing-in boxes; to be laid in the parish of Shoreditch. Specification, with form of tender, can be obtained from the consulting engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of three guineas, which will be returned on receipt of a bona fide tender. Tenders, endorsed "Tenders for Electrical Mains," to be sent by 17th September to Mr. H. Mansfield Robinson, vestry clerk and solicitor, Town Hall, Old-street, E.C.

Gravesend.—Tenders are requested for the supplying of a telephone, and providing, delivering, and fixing, etc., of the necessary poles, wires, instruments, and plant at regulation distance of a specified description, from the sanatorium to the office of the sanitary inspector and the police station, for the Town Council. Tenderers are also requested to specify an amount per annum at which they would maintain the communication. Further particulars can be obtained of the sanitary inspector, Town Hall. Tenders, marked "Sanatorium Telephone," must be delivered to Mr. Chas. E. Hatten, town clerk, Gravesend, by September 20.

Stafford.—The committee of the Staffordshire County Infirmary invite tenders for wiring and fitting the infirmary for electric light. Tenders, sealed and addressed to the Secretary, Staffordshire County Infirmary, Stafford, and endorsed "Tender for Electric Lighting," must be received by him not later than noon on September 14. Copies of the specification, with form of tender attached, can be obtained from the secretary on payment of £1, which will be returned on receipt of a bona fide tender; and plans may be seen on or after Monday, September 2, at the infirmary, or at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George street, London, S.W.

Dundalk.—The Dundalk Town Commissioners invite tenders for erection of an electric lighting installation for the purpose of lighting the town by electricity on or about July 1, 1896, reserving to themselves the right of taking over the plant at the end of a term of years—this term to be stated in the tenders. The successful contractor to have the right of supplying private consumers, while the Commissioners will pay a fixed sum yearly for the town lighting—this sum to be stated in the tender also. The Commissioners have obtained a license from the Board of Trade for supplying electric lighting. Tenders will be received by Mr. Edward Farrar, town clerk, Town Hall, Dundalk, up to October 7.

Sunderland.—The Corporation of Sunderland are prepared to receive tenders for the following: (*a*) high-tension and low-tension concentric cables; (*b*) cast-iron pipes, and box frames and covers; (*c*) stoneware casing, boxes, and bellmouth protectors; (*d*) high-tension transformers for alternating current; (*e*) meters for alternating current. Specification, conditions of contract, and form of tender may be obtained on payment of £1 1s. at the office of the borough electrical engineer, Electric Supply Station, Sunderland. The deposit will be refunded on receipt of the specification and conditions of contract with a *bonâ fide* tender. Sealed tenders, addressed to the chairman of the Highways Committee should be delivered at the town clerk's office by 6.30 p m on Friday, September 13.

Queenstown (Ireland).—Tenders are invited by the Queenstown Town Commissioners for the lighting of Queenstown by electricity (private as well as public) as per report and specification of Mr. R. Hammond, M.I.E.E., Ormond House, London. Tenders are also invited as follows: the contractor to provide the capital for the due erection of the works and maintenance thereof as per above plans and specifications, on being guaranteed the public lighting, and a stipulated number of private lights (to be agreed upon), the Commissioners having the right to purchase within a specified period. Plans and specifications are deposited at the Hall, Queenstown, and can be inspected there between 11 and 2. Tenders must be lodged with the town clerk, Queenstown, marked "Tender for Electric Lighting," by 2 p.m. on September 16. Further particulars and conditions to be had on application to Mr. James Ahern, town clerk, Queenstown.

Manchester.—Tenders are invited for the execution of the following works, for the Manchester Corporation—(Contract 2) laying a system of underground telephone pipes, with brick inspection pits, service boxes, and other appurtenant works in the following streets: route 6—Little Peter-street, Chester-road, Hulme Hall road, to a point adjoining the Ship Canal. Laying a system of underground telephone pipes with brick inspection pits, service boxes, and other appurtenanant works in the following streets (Contract 3)—viz.: route 1—Dickenson street, South-street, Jackson's row, Deansgate, Atkinson-street, Byrom-street, Camp-street, Charles street; route 2—Dickenson-street, George-street, Nicholas-street Booth-street, Tib lane, Cross street, South King street, Deansgate Lower King-street, Ridgfield, John Dalton-street; route 2A - Pall-mall, Moult-street, Bank-street, Half Moon street; route 2B—Bank street, Exchange-street, St. Mary's-gate, Blackfriars-street, Parsonage; route 3—Faulkner-street, Charlotte street, Back George street; route 3A—Charlotte-street, Fountain street, Marble-street, High street, Cannon-street, Hodson's square; route 3B—High street, Nicholas croft, Bradshaw-street, Cross-street, Balloon-street, Holgate-street, Corporation-street, Mark-lane. Drawings may be seen, and copies of specification, bills of quantities, and forms of tender for each contract may be obtained on application at the city surveyor's office, Town Hall, Manchester, on September 9, on payment of £2. 2s. and £5. 5s. respectively, which sums will be refunded on the return of the documents and the receipt of bona fide tenders. Sealed tenders, enclosed in the official envelopes, to be sent in by 5 p.m. on September 17.

RESULTS OF TENDERS.

London, N.—For the wiring of the Vestry Hall and municipal offices in Upper-street, N. and for the supply of fittings, for the Vestry of St. Mary, Islington: S. Newton and Co., 15A, Baker-street, W., £215 (accepted). Note.—32 tenders received.

Belfast.—The Electric Committee of the Corporation have accepted the following tenders: Messrs. Shaw and Co. for cast iron, Messrs. Doulton and Co. for insulators, the Callender Bitumen and Telegraph Company for cable, the British Insulated Wire Company for copper strip, Messrs. Coates and Son for road-work Messrs. Robert Patterson and Son for inspection plugs, and Messrs. Wormald and Co. for covering exhaust-pipes.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,038.

Direct Spanish Telegraph Company.—For the month of August the receipts were £1,957, as against £1,583 for the same period of 1894.

Easton-in-Gordano (Glos.).—The Parish Council have resolved that a committee be formed to enquire into the best means and cost of lighting the parish.

Wells.—The Town Council have retained the services of Dr. Hopkinson to advise them with regard to the electric lighting of the city, at a cost of £52. 12s. and travelling expenses.

Commercial Cable Company.—This Company has declared a quarterly dividend of 1¾ per cent., payable on October 1. The transfer books will be closed on September 20, and reopened on October 2.

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West India and Panama Telegraph Company.—For the two weeks ended August 31 the receipts show a decrease of £181 as compared with the corresponding period of 1894.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 1st inst. amounted to £1,272, as compared with £1,152 in the corresponding week of last year, being an increase of £120.

Liverpool.—A meeting of the Special Lighting Committee of the Corporation has been held at which the engineer was instructed to report as to the lighting of the added areas in connection with the extension of the city boundaries.

The City Electric Light and Power Engineering Works.—We have received a copy of the new catalogue of dynamos, arc lamps, motors, and alternators issued by this firm (L. C. H. Mensing) from 89, Worship-street, London, E.C.

Tunbridge Wells.—The Lighting Committee of the Town Council have appointed Mr. E T. Stuart assistant electrical engineer, at £100 per year salary. The Mayoress (Lady Salomons) is to be asked to publicly open the new works, and it is proposed to hold an electrical exhibition in October.

Oswestry.—The Town Council have received a letter from the Oswestry Electric Lighting Company stating that the current would shortly be laid on in the proposed area, except Willow-street, and that the charge would be 7d. per unit.

City and South London Railway.—The returns for the week ended September 1 were £786, compared with £794 for the corresponding period of 1894, being a decrease of £8. The total receipts for the half-year 1895 are £7,669, compared with £7,735 for the corresponding period of 1894, being a decrease of £66.

Public Works in Natal.—The Corporation of Durban, Natal, have decided, it is stated, to raise £110,000 of stock for improvements in the town, to be expended as follows: £60,000 for a promenade, £25,000 for lighting the town by electricity, and £25,000 for the completion of the scheme for an adequate supply of water.

Mile End.—The Works Committee of the Mile End Board of Guardians have reported on the proposed lighting of the institutions of the Guardians by electricity, and recommend that the question be deferred for the present. Mr. A. Druitt moved, and Mr. Brien seconded, the adoption of the report, and it was agreed to.

Hull.—A meeting of the Hull Corporation Electric Lighting Committee has been held for the purpose of appointing an engine-driver. There were six applicants who appeared before the committee: J. T. Alton, E. Boyd, C. S. Hall, R. H. Harman, J. Morley, and J. N. Naylor. Mr. Alton was finally selected for the position.

Ship-Lighting.—The twin-screw steamer which Messrs. Lobnitz and Co. are about to build for the Japanese Government will be fitted complete with cable-laying gear of the most modern design by Messrs. Johnson and Phillips, and also with electric lighting plant and fittings for the whole of the vessel. We hope later to publish particulars.

Llanelly.—At the Llanelly Borough Council on Tuesday it was reported that the cost of lighting the centre of the town and the municipal buildings by electricity would be £10,000 It was moved and seconded that an electrical engineer be engaged to report as to the best method of carrying out the work, but an amendment was moved, it being contended that the time had not yet arrived, having regard to the experiences of other towns, for incurring the expense, and the amendment was carried by a large majority.

Eastbourne.—The Lighting and General Purposes Committee of the Town Council have resolved to recommend the adoption of the proposals of the Telephone Sub-Committee that the wires sent through the exchange be altered to pass through the police station, excepting those which were to remain on the exchange, that an additional line be connected from the police station to the destructor works, and that the estimate of the Telephone Company for carrying out the above alterations, amounting to £210, be accepted.

Newhaven.—On the report of the sanitary inspector a member of the Rural District Council has brought up the question of the lavatory accommodation that is being provided on the new pier at Rottingdean, erected by the electric railway company, and said it was proposed to empty the cisterns at high water. This proceeding the whole village objected to, as the landing-stage being immediately opposite where the bathing machines were, it was felt this would very materially affect the prosperity of Rottingdean as a bathing resort.

Wrexham.—A letter has been received by the Town Council from the Board of Trade enclosing a copy of a letter addressed to the secretary of the Wrexham and District Electric Supply Company, Limited, stating that the Board would defer consideration of the question of the revocation of the provisional order for a further period of six months from 15th ult., and adding that if at the expiration of that time the undertakers have not taken the necessary steps to give effect to the order, the Board of Trade will not be prepared to grant any further extension of time, but will proceed to revoke the order forthwith.

Belfast.—At the last Corporation meeting Alderman Haslett asked if the £25,000 lent to the Electric Committee was carried forward as a debt or not. Alderman Dixon said the sum referred to stood as a debt in the books. With regard to the electric undertaking, Alderman Haslett said that they were glad to see that it competed so favourably with gas, but he was inclined to think that it had not made anything like the same advance as some of the newer forms of gaslighting. They saw, for instance, the incandescent gaslight very rapidly coming to the front. At the same time, in a sanitary sense, electric lighting was far ahead of any other form.

Weymouth.—The directors of the Weymouth Waterworks Company, acting upon the advice of their engineers, Messrs. Crickmay and Sons, have instructed Mr. George Jennings, of Lambeth, London, to carry out an installation of his patent electrical indicating and recording apparatus between the reservoir and engine-house. By the adoption of this apparatus the level of water from the reservoir will be shown in the engine-house at all the hours of the day and night throughout the year, and a record of the varying depth will be automatically registered for reference. Mr. Jennings will also shortly fix a similar apparatus at the Great Yarmouth sewage pumping works.

Appointment Vacant.—The Electric Lighting Committee of the borough of Kingston-upon-Hull are prepared to receive applications for the appointment of a resident electrical engineer to take charge of their electric lighting station. The person appointed will be required to devote the whole of his time to the duties of the office, must be competent to advise upon the construction of all necessary works, the acceptance of tenders for the same, and to undertake the supervision of the works when completed. One who has had actual practical experience of central-station work will be preferred. Salary £250 per annum. Applications, with copies or prints of not more than three testimonials of recent date endorsed "Electrical Engineer," to be sent to Mr. R. Hill Dawe, town clerk, by Thursday, September 19.

Edinburgh.—The Town Council have received a letter from the general manager of the National Telephone Company suggesting that the Corporation should lay underground tubes for telephone wires at the company's expense. Sir James Russell said he did not think it was the least likely that the Council would entertain the proposal, which would only have the effect of confirming the telephone monopoly in the city. He thought the Council should give underground rights to no private company. The letter was sent to the Lord Provost's Committee. On a letter from the superintending engineer, Post Office Telegraphs, the Streets and Buildings Committee will report grant of permission to open the street on the south side of George street, the west side of South St. David-street, and south side of Princes street, for the purpose of laying an underground telephone line.

Portable Electric Lamp Company, Limited.—This Company has been registered, with a capital of £50,000 in £1 shares. Object: to acquire from William Morison and Andrew P. Morison, upon such terms as may be arranged, the benefit of a certain invention, entitled "Improvements in Portable Primary Batteries," and the letters patent granted in respect thereof (No. 9,826, of May 21, 1894; also the benefit of an invention or discovery of a composition suitable for the manufacture of the cases of the said batteries, and improvements therein, and of a chemical compound known as "electric sand," suitable for the generation of electricity, for use with the said batteries; also to manufacture, deal in, or let on hire steam, gas, and other engines, dynamos, machinery, cables, wires, batteries, electric motors, miners' electric safety-lamps, meters, instruments, fittings, and other electric appliances.

Dover.—The Harbour Board have decided to further improve the landing and embarking arrangements at the Admiralty Pier, by the construction of electric cranes for the transference of passengers' luggage between vessels and trains. The traffic between Dover and Calais and Dover and Ostend has grown so much lately that this convenience will often save 20 minutes more in the despatch of the mail steamers. At a special Council meeting Councillor Thorpe moved to rescind the contract with the Dover Electricity Supply Company for the lighting of Snargate-street. He argued that there would be a saving of £1,260 on the seven years if they adopted the incandescent gas lamp instead of the electric light. The Town Clerk advised that the Council would be responsible for any expense incurred by the electric lighting company if they broke their contract, and after considerable discussion the motion was lost by three votes.

Cork.—At a meeting of the Waterworks Committee the Chairman said that they spoke frequently as to the practicability of introducing electric light into the waterworks, but up to the present, owing to the cost of installations and lamps, it was always found too expensive, and there was also some difficulty about getting the necessary power to drive the dynamo. They were now getting their new turbines in, and during the winter months they would have a surplus power in their water-engines, and finding there was an electrical engineer at present in Cork fitting up the electric light in various places, he (the chairman) directed Mr. O'Toole (waterworks superintendent) to see him on the subject. He (the chairman) then had a conversation with Mr. O'Toole, and from the figures given him he had no doubt that they could effect a saving of £50 a year by adopting the electric light, in addition to having a much better light than they had at present. He would suggest that the matter be referred to Mr. O'Toole to report on. This course was adopted.

Tipton (Staffs.).—At the last meeting of the Urban District Council a letter was read from the town clerk of Wednesbury pointing out that the date by which the tramway company would have to apply for the renewal of the license for the use of steam would shortly expire, and suggesting the advisability of the local authorities through whose districts the tramway ran meeting in conference to discuss the matter. Councillor Steadman thought a conference a very good idea, for it would be a serious thing for the public if the trams were to stop running. Councillor Butler

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said according to the shareholders' report the company did not seem to be in much of a position to provide any other mode of traction. Councillor Doughty thought the representatives of the Council at the conference should not pledge themselves to accept any particular mode of traction. At the last conference it was stated that they might favour overhead wires, but, personally, he should strongly object to overhead wires. They were very dangerous. It was ultimately agreed that the chairman, the clerk, and the surveyor should attend the conference.

Alderley Edge (Cheshire).—At the meeting of the Alderley Edge District Council, the accounts for the expenses incurred in obtaining the electric lighting provisional order were presented to the Council. The total was £272. 7s. 2d., and it was stated by the clerk that there was an addition to this amount of £50 paid to the Local Government Board. Dr. Burghardt and Mr. Church, councillors, objected to the amount, alleging that they had been given to understand that the order was only to cost £250 at the outside. Considerable discussion took place on the matter, and it was finally resolved to refer the accounts to the Finance Committee. A letter was read from Mr. S. V. Clirehugh, electrical engineer, of Manchester, offering to buy the provisional order from the Council, and stating that he was authorised by his clients to offer in return for the order to pay the costs incurred by the Council in obtaining it, and to say that his clients were prepared to supply electricity for lighting purposes at the cost of 32s. 6d. per lamp. The clerk stated that the cost per lamp at present was 35s. This matter was also referred to the Finance Committee for consideration.

Lancaster.—At the last meeting of the Town Council a letter was read from Mr. J. W. Pickard, objecting to carrying electric current wires forward from Haverbreaks Bridge to Oatlands, and suggesting that the Corporation should lay the wires, and he would pay interest on the capital outlay. It was resolved that the borough surveyor be instructed to lay cable mains to Oatlands of such capacity as he may deem advisable, subject to Mr. Pickard paying to the Corporation 10 per cent. per annum, for not less than six years, on the cost of the cable mains beyond Haverbreaks Bridge, such payment of 10 per cent. to be in addition to the usual charge for current. On the motion for the confirmation of the proceedings of the Electricity Supply Committee, Mr. Bowness referred to the unusually heavy cost of lamp-pillars and asked if the committee were obliged to go one firm for pillars of a registered pattern. Could not some other means be adopted which would reduce the cost of the pillars? Mr. Alderman Bell said originally the committee got estimates from four or five firms who made these pillars, and they accepted the lowest. An electric light pillar was a little different from an ordinary casting; it was of great length and had to be cast in a different way, so that this might add to the cost. The minutes were confirmed.

Ripon.—At the monthly meeting of the City Council a discussion took place with reference to the introduction of the electric light to the north end of Ripon, Messrs. Harrison and Co. having already installed public electric lamps at Ure Bank, across the River Ure, in the township of Sharrow. Councillor Lee said he should be sorry if the Corporation were to make up their minds to fight against the introduction of the electric light. The Town Clerk stated that the Corporation would have power to object to the introduction of the electric light. They might issue a license to any company, or they might promote electric lighting themselves. Councillor Lee urged that the supply of the electric light to Ripon would be a great boon. It could be brought across the river from Ure Bank at a moderate charge, and its introduction would be an advantage to the inhabitants and a step in the right direction. Councillor Husband urged that it was not merely a question whether the company was going to supply the electric light, but whether they were going to allow anyone else to supply it for private purposes. He moved that the subject be considered at a special meeting of the Council, and that in the meantime the gas company make a full report on the question. Councillor T. Wells seconded the motion, which was carried by seven votes to two.

Halifax.—The town clerk of Halifax has received from Messrs. Simpson and Marwick, of Heriot-row, Edinburgh, an application, on behalf of clients in that city, "for a concession conveying to them the exclusive right to construct and work a system of tramways in Halifax on the Hallidie cable principle." The subject was referred to the Tramways Committee of the Halifax Corporation, who, after discussing the project, passed the following resolution: "That it be a recommendation to the Council to favourably consider the application with a view to the introduction of tramways into Halifax, and that the assent of the Council be given to the request, on condition that an agreement embodying details satisfactory to the Council be executed by the company." It has been decided to spend a considerable sum in further extending the electric light at the Theatre Royal, and in rendering the house as safe and comfortable to the public as possible. The whole of the stage, orchestra, and other parts of the house are to be lighted thoroughly by incandescent lamps, numbering about 300 in all, and in addition the limelights are to be replaced by electric arc lamps of special design to enhance the scenic effects. The work is being carried out by Messrs. Walter Emmott and Co., who have already lighted the auditorium and the front of the house. In addition to the electric light, Grenell sprinklers are to be fixed, by which any risk through fire will be reduced to a minimum.

Woking.—A meeting of ratepayers has been held at the Westfield Schools to take into consideration the proposal of the Woking Urban District Council to light the village. Mr. Wooldridge, the surveyor, read an extract from a report to the Council on the subject, in which he said that from enquiries he had made he did not think the gas company would be at all disposed to extend their mains to the district which was now proposed to be lighted, as the cost of so doing would be very great. The electric supply company would be prepared to extend their mains a certain distance, but he thought it would be very unfair to light the village street and leave Westfield and Mayfield in the dark, seeing that the whole of the ward would have to bear the expense. The speaker then referred to oil lighting, and read estimates from which it appeared that the capital expenditure for lighting, partly with electric light and partly with oil, would be £127. 10s., and the working expenses £124. 3s., so that the annual cost of lighting in this way would be equal to a half-yearly rate of 3¾d. on the assessable value and 2¼d. on the ratable value. The next estimate was for lighting the ward entirely with oil. The capital expenditure in this case would be £85 and the working expenses £86 10s., making the annual cost equal to a half-yearly rate of 2¼d. on the assessable value and 1½d. on the ratable value. Resolutions were then put to the meeting from the chair, and it was decided that the lighting should be in the hands of the Urban District Council, and that the ward should be lighted wholly with oil.

Salford.—Mr. W. Bird Clerke, C.E., has held an enquiry at the Salford Town Hall, on behalf of the Local Government Board, with reference to an application of the Salford Corporation to borrow £18,000 for the purposes of electric lighting in the borough. Mr. Brown (the town clerk) stated that some time ago an application was made to the Local Government Board for power to borrow £50,000 for electric lighting, but £32,000 only was sanctioned, and the present enquiry related to the balance of that amount. The Corporation proposed to spend about half the sum almost immediately, and they hoped it would not be necessary to hold a further enquiry to obtain the sanction of the Board for the remaining £18,000. They trusted the Board would allow them to forward them the estimates for the further expenditure, and that upon being satisfied as to the correctness of those estimates they would sanction the borrowing of the sum required. The Inspector did not think the Local Government Board would sanction a loan for more than the Corporation definitely proposed. If they could submit a definite proposal for the balance of the £18.000, he, personally, saw no necessity for a further enquiry. Mr Edward Manville, the engineer appointed for carrying out the electrical lighting in the borough, explained some of the details of the scheme, and observed that the works had been carried out in accordance with the plans originally submitted to the Local Government Board. In regard to the present application, they could simply show an estimate of expenditure amounting to £7,770. With the exception of £1.500 to be expended on premises, this sum was entirely for the extension of mains and for the provision of the necessary apparatus for the utilisation of the current passing through the mains. The extensions were outside the compulsory area. This was all the evidence that was submitted, and the enquiry then closed.

Aberdeen.—At a meeting of the Gas Committee of Aberdeen Town Council proofs of the accounts of the Corporation gas and electric light for the year from July 31, 1894, to July 31, 1895, were submitted. The gas accounts showed a revenue of £76,821. 1s. 3d., and an expenditure of £63,944. 4s. 6d., leaving a balance to be carried to the net revenue account of £12,876. 16s. 9d. Annuities, interest, sinking fund, reserve and fire insurance fund, etc., had to be paid out of that, and a surplus of £398 more was absorbed, the result being to bring out a deficiency on the electric lighting department at December 31, 1894, of £217. 15s. 6d. With regard to the electric light, Mr. Cran had prepared a statement of accounts with the view of showing the Town Council how the department was working. The year, however, according to the Board of Trade regulations, finishes at December 31, and he will have to prepare another statement at that time. The department shows very good results. At the beginning of the year the Council reduced the price of the electric current from 7d. per unit to 6d. per unit, and up to July 31 the net deficit was only £109. 3s. 1d., which was considered to be very satisfactory. The accounts showed the revenue to be £2,975 (omitting shillings and pence), of which £2,704. 17s. 8d. was for sale of current per meter; £154. 12s. 8d. for public lighting, and £115 for rental of meters. On the expenditure side fuel cost £242; wages at generating station, £233; feu-duty and taxes, £125; salaries of engineers, £244. The balance carried to net revenue account was £1,815. 17s 10d., which, with £109 in addition, the loss for the year, is absorbed in paying interest on mortgage and other loans, £656; depreciation, £730; sinking fund, £538. A statement of the electricity generated shows that the quantity in Board of Trade units generated was 118,193; public lamps absorbed, 8,163; private consumers by meters absorbed 98,122; and the total quantity sold was 106,285. The quantity used in the works was 1,570, making the total quantity accounted for 10,338, and the number of public lamps was 10. In the course of the meeting of committee new rules, submitted by the electric engineer, for wiring houses were agreed to.

Nottingham.—The annual report of the Lighting Committee of the Corporation states that the committee have conducted the business of their department as usual during the year ending March 31 last. The following is the report of the lighting superintendent for the year: "Number of lamps March 31, 1894, 3,522; fixed since, 49; discontinued, 7; increase, 42—total number March 31, 1895, 3,564. Patent lanterns, March 31, 1894, 551; fixed since, 17; discontinued, 3; increase, 14—present number, March 31, 1895, 565. Electric lamps fixed since March 31, 1894, 8. (The patent lanterns and electric lamps were included in the above total of 3,564.) The position of 23 lamps had been

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altered during the year. During the year eight columns had been broken and the cost of replacing them charged to the persons causing the damage. Four convictions had been obtained for damaging lamps and one for an assault on a lamplighter. The number of private lamps lighted and cleaned at the cost of the owners was 116. The staff on March 31, 1895 consisted of one superintendent and 42 lamplighters. Since the date of the last annual report the electric lighting station of the Corporation had been opened, and the committee thought the opportunity a good one to improve the lighting of the Great Market place. They therefore consulted Mr. Talbot, the electrical engineer, and under his advice and superintendence eight 4,000-c.p. electric lamps were erected, which were found to light the Market-place very efficiently and to be a great improvement on the lighting by gas. The committee had been able to remove permanently two of the large Bray lanterns formerly in use, and while the electric lights were burning the use of 18 more of the Bray lanterns was dispensed with, the value of the gas thus saved materially reducing the expense of the electric lights. The electric lamps were lighted on weekdays only, and the current was switched off at 11.15 p.m. At the Town Council meeting Mr. Pyatt drew attention to the lighting of the Market-place, and thought that as the electric lamps were lit at night it was a waste of money to keep the gas lamps alight. Alderman Ford remarked that the electric lights were extinguished at a quarter past eleven. The Sheriff asked why the electric lamps were not lit on Sunday night. He moved as an amendment that they be lit on Sunday nights mainly on the ground of convenience. Alderman Ford: They cost about 16s. an hour. For my part I think it very undesirable to have them alight on Sunday nights. Mr. Pyatt seconded the Sheriff's amendment. He thought that the town electric lamps should be lit for a certain period of Sunday night. He did not say for the whole night, but it was desirable that people assembling in the Market-place should have light. The Mayor: If the committee are prepared to do it all very well, but otherwise notice of motion must be given. Mr. Bentley: The lights might be turned out at 10 o'clock. Alderman Ford: If you will leave it to the committee they will undertake to consider the question.

Blackpool.—The *Blackpool Times* of September 4 has the following: Whatever views we may hold as to the decision of the Council to stop all further electrical extensions for a year—practically for two years—there can be no doubt as to the interest of the debate. Councillor Pearson was on his mettle, and a more able speech was never made in the Council, but the Blackpool Town Council seems quite incapable of coming to a decision on the merits of a case. There are so many conflicting interests, so many cross currents and by-questions, that it is impossible to get a straight vote in the Council on the merits of the question. Mr. Pearson's facts and figures are plain and clear, and place it beyond doubt that there is a great necessity for immediate development in our electrical supply. Stripping the question of all side issues, the simple fact is clearly established in Mr. Pearson's statement that the demand exceeds the supply. The decision of the Council practically means that unless we get rid of our largest customer—the Winter Gardens—we shall have no further supply of electricity for two years, at any rate for new customers. More than that, so extreme is the course taken as a result of carrying Councillor Ward's amendment, that we cannot even supply our present customers without risk of breakdown and disaster. Many people have fixed wires and other inside electrical appliances in their houses, in the expectation that they would soon be connected with the mains, and have their houses and other premises lit by electricity. They may take their wires down, and keep to gas, or return to oil and candles! The Electric Lighting Committee are at any rate relieved of responsibility, and may indulge in a Rip Van Winkle sleep for two years at least, unless the folly of yesterday's vote be discovered very soon. Just when our electricity has a chance of turning the corner, and by increasing the number of units supplied, for which there is ample demand, reducing the cost of production per unit, so making a profit for the ratepayers, the Council in a panic-fit upsets everything. It is not only two years that are lost to Blackpool's development in this particular, but more, for it will take a much longer time to win back the ground lost. Councillor Ward is a strong opponent, and he made the most of every point. But what does it all amount to? Simply that our electricity works are not yet making a clear profit, in the second year of working, though they are practically paying their way. He chooses for comparison with Blackpool, Newcastle, where the conditions are the most favourable in the kingdom for electrical production! Then he complains that the Winter Gardens and others get their light for 4d. a unit, when the town is charged 6d. But he forgets that these private consumers have to find, maintain, and keep in repair their own lamps. We are very glad to get these customers at the beginning of our electrical enterprise, and but for them there would have been but little hope of making the system pay at all. Councillor Ward's description of his own criticism as "mild" was correct, but he was quite straight, and the issue was clear enough, and so our electrical development is stifled indefinitely. We venture to predict that the Council will regret its decision. As to his attack on the tramway policy, the simple and complete answer is that, in spite of the cost he complains of, the tramways show a profit for the year up to date of £2,800. The committee have almost had to make a new line, while the figures he gave included the cost of new plant, dynamos, and cars, and this accounts probably for the apparent discrepancy between his estimate and that of the committee. Now that the opposition have succeeded in shelving Mr. Hammond, they have the responsibility of showing that they can organise electrical works themselves, and we shall see how they succeed.

Exeter.—A special meeting of the City and County Council has been held to consider the advisability of negotiating with the Exeter Electric Light Company for the acquisition of their undertaking. The Mayor presided. The Town Clerk said the meeting was convened under the direction of the Deputy-Mayor (Mr. E. J. Domville), acting in the absence of the Mayor. He had received a letter from Messrs. Roberts and Andrew, solicitors to the electric light company, who stated that they understood a meeting of the Council was to be called to consider this question. It was no doubt known that the company had been made an offer of £7,000 from a large London firm for their undertaking, and there was a syndicate of local gentlemen who would be prepared to give over £8,000. The critical condition of the company rendered it necessary that an immediate decision should be come to, and if the Council were willing to purchase for £10,000, the directors would recommend the proprietors to accept that amount. A memorial signed by all the principal tradesmen in High-street, Fore-street, and Queen-street had also been received in favour of the acquisition of the works by the Council. Mr. Domville said he had called the special meeting of the Council in response to a requisition he had received. Of course, that did not pledge the authority to take any action in the matter; it simply gave them an opportunity of considering the question and hearing what their legal position was. Under the provisional order, if the company became insolvent the Board of Trade could transfer its powers, and certain conditions were laid down under which the undertaking could be purchased. The matters involved required careful consideration. The less one said about the management of the company the better, but it was evident that misfortune had dogged its footsteps from the beginning, and the expenditure of a capital of £23,000 had not resulted in any profit to the shareholders. A large portion of that capital was now valueless to a purchaser, and what they had to think of was the present value of the undertaking, the possibility of the company carrying out its obligations, and the further demands that would be likely to be made on any purchaser in extending the works. They had also to consider whether it would be wise for them to wait the 17, 18, or 19 years that must expire before they could acquire the works under the provisional order, or whether they should seize the opportunity which now offered itself of purchasing them. He thought it would be best to refer the whole subject to a special committee, and he moved that that should be done. Mr. Ward seconded. After some discussion Mr. Domville withdrew his motion, and Mr. W. Wreford moved a resolution declaring it to be expedient that the control and supply of the electric light in the city should be in the hands of the Council. By doing this they would only be reaffirming what they did three or four years ago, when they promoted a provisional order in opposition to one applied for by the present company. Mr. E. C. Penny seconded. He had always held that such an important element of civilisation as light should be in the hands of the municipality. He thought the city made a great mistake in not purchasing the gasworks when they had the opportunity some years ago, and if they let this chance slip they would be making another mistake. Mr. Jarman supported the motion. In reply to Mr. Fulford, the Town Clerk said in this case it would not be necessary to take a poll of the ratepayers. The motion was carried, 29 voting for and none against. Mr. Wreford then proposed that it was desirable to enter into negotiations with the electric light company with a view to acquiring their undertaking. The company had come to the conclusion to transfer their shares and debentures to a London firm for £7,000 and they had no reason assigned yet why the Council should go further and offer £10,000. But that was a matter of detail which could be threshed out in committee. Was that a favourable opportunity for purchasing? Under the provisional order they could at the end of 26 years take over the works by paying the value of the plant and an equivalent to the previous five years' profits, and only at the end of 42 years could they acquire the property without paying anything for profits. They had now a chance of getting the undertaking on much better terms, and he believed they could effect the purchase without inflicting any pecuniary burden on the ratepayers. Mr. E. C. Perry seconded and after some remarks from Alderman Houlditch, who said he hoped the proceedings would result in the streets being lighted by electricity at an early date, the motion was carried. The further consideration of the matter was referred to Council in committee, with power to appoint a special committee to decide points of detail.

Cheltenham.—A correspondent writes: "The interior of the Public Library presented an unusually animated appearance at 9 p.m. on Monday, and though the hour was a somewhat late one for a public ceremony, none more suitable for the important business in hand, which was no less than the inauguration of the electric light in the building. To make way for the electric light all the gas fittings had been bundled out 'neck and crop,' and during the time that the workmen had been engaged in putting in the fittings for the new illuminant the library had been lighted by something even more primitive than gas—to wit, oil, which somewhat feebly illuminated the place when the guests of the Public Library Committee assembled there on Monday evening. The installation cost about £112, and was carried out by Messrs. Marshall and Co. from specifications prepared by Mr. Kilgour, resident electrician. One and a quarter mile of wire was used, and altogether 141 incandescent lamps (exclusive of the electrolier) were placed in the building, varying from 8 c.p. to 32 c.p., and giving a total illuminating power equal to that of 2,712 candles. The lamps are distributed in the principal rooms as follow: news-room, 52 lamps, 688 c.p.; reference library and book-store,

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36 lamps, 912 c.p.; lending library and book store, 29 lamps, 624 c.p.; corridor, eight lamps, 120 c.p.; basement, 16 lamps, 208 c.p. The main switch in the basement controls the whole of the installation, and thence the mains are carried first to a distributing board in the basement, and then to the main distributing board on the ground floor, where the current is divided into 11 circuits. In the news-room there are four circuits—one for centre lights, one for tables, one for brackets, and one for newspaper stands—so that each set of lights may be used separately as required. In the lending library there is a circuit for counter and indicators, but in addition there are six circuits for the book-stores at the back. The reference library has three circuits, two for the tables and one for the book-store. In the public part of the reference library each lamp has a separate switch. In the lending as well as in the reference library switches are placed over each alcove, so that when economy so dictates the light may be switched off where it is no longer needed. The corridor and stock-room have also a circuit to themselves. The electrolier, presented by the Baron de Ferrieres, which forms a striking ornament of the vestibule, has a separate circuit, lighting nine 32-c.p. lamps, equal to 288 c.p. It was designed and executed by the contractors in wrought iron, with copper ornaments. The position of the lights was arranged by Mr. Kilgour, resident electrician, and by Mr. Jones, chief librarian." At the last Town Council meeting the fire brigade superintendent recommended that the existing fire bell be removed, that each member of the brigade be connected with an electric call bell, and that his private rooms should be connected by telephone direct with the fire station or through the exchange. It was resolved that the recommendations of the superintendent be left to the sub-committee to consider. The electrical engineer reported to the Lighting Committee that about 50 arc lamps would be required to light the Promenade to the Gordon lamp, Clarence-street to the Great Western Railway Station, Ambrose street and High-street, from Ambrose-street to the Royal Hotel, replacing 311 gas-burners, and averaging 30 to 40 yards apart in the Promenade and about 70 to 80 in the remaining streets The estimated capital costs were: alternating-current system £3,100, rectified-current system £5,070, assuming all the lamps were supported on pillars If the arc lamps in the Promenade were supported on centre arches, the additional cost per arc so supported would be £20 to £30; and with 30 all-night arcs and 30 arcs switched off at midnight the total annual costs would be; alternating-current system £957, or about £19. 10s. per arc; rectified-current system £1.075, or about £21. 10s. per arc. It was resolved that the report be approved, and that the committee propose to act on the lines indicated by it, and to adopt the alternating-current system for street-lighting. It was also resolved that the electrical engineer be authorised to engage a clerk at a salary not exceeding 12s. a week. Mr. Williams, secretary of the Cheltenham Theatre Company, complained of insufficient light in Ormond-place and Regent-street. It was resolved to place additional lamps in Eldorado-road, Cranham-road, and Whaddon-lane, and to consider the feasibility of lighting the town clock by electric light. It was also resolved to pay the poor-rate assessment of £320 on the electric station under protest. It was resolved to obtain transformers at the estimated cost of £123, to lay a cable in High-street at a cost of £180, to obtain from Messrs. Belliss and Co. an engine capable of driving direct a 100-kilowatt alternator for £729. 17s., and to do minor works.

Hampstead.—In his annual report on the work of the Vestry for the year ended March 25, Mr. A. P. Johnson, the vestry clerk, says, under the heading "Electric Lighting": The foundation-stone of the central electric lighting station, situate in the stone-yard, Lithos-road, was formally laid by Mr. J. Thwaites, chairman of the Lighting Committee, on May 23, 1894. The station, plant, and mains were completed and in working order by the end of September, and the electric current was first supplied to consumers on October 1, when, at the opening ceremony, held in the evening of that day, the current was switched on by Mr. R Hackworth. There has been some slight trouble with the public arc lamps in the Finchley-road, but those difficulties which arose have been speedily grappled with, and at the present time the public lighting of the Finchley-road, from Arkwright-road to Boundary-road—*i.e.*, the end of the parish—is a complete success. The private lighting has worked very smoothly from the commencement of the supply on October 1. At that date there were 13 consumers, with an equivalent of 1,648 8-c.p. lamps connected to the mains. At Christmas the number of 8-c.p. lamps installed had risen to 4,000, and on March 25 to 6 500 Since the period covered by this report the total number of consumers has risen to 116, with an equivalent of 11,879 8-c p. lamps connected. This will show the large strides the electricity department has made since the station was opened. The Vestry are, at the present time, carrying out very large extensions, notably the High-road, Kilburn, and West-end-lane. The applications for current from intending consumers are of such a character that the Lighting Committee are even now seriously considering the advisability of increasing their plant at the station. The Vestry have had under their consideration the public lighting of the High-road, Kilburn, with arc lamps. The Willesden Urban Council, who have part jurisdiction of that road, were approached on the subject, and the Vestry submitted the terms upon which they would undertake the lighting. These terms were not acceptable to the Willesden Urban Council, and so the Vestry have reluctantly been compelled to let the matter stand in abeyance. The mains for the supply of electricity to private consumers are laid in the following roads—viz.: Arkwright-road, Belsize-avenue, Belsize-grove, Belsize-lane (from Daleham-gardens to Fitzjohn's-avenue), Belsize-park, Belsize-park-gardens, Buckland-crescent, Daleham-gardens, Eton-avenue, Finchley-road (from Boundary-road to Langland-gardens). Fitzjohn's avenue, Frognal (from Finchley-road to Arkwright-road), Gayton-road (from High-street to No. 11), Haverstock-hill (from Rosslyn-hill to Belsize-grove), Heath-street (from Church-lane to High-street), High-street, Lindfield-gardens, Lithos-road, Lyndhurst-gardens, Lyndhurst-road, Maresfield-gardens, Netherhall-gardens, Nutley-terrace, Rosslyn-hill, Strathray-gardens, Wedderburn-road, Windsor-terrace (from Lyndhurst-road to Springmead). Extensions of the mains have also been ordered on the following roads, and are being carried out as quickly as possible—viz.: Belsize-square (east and west sides), Branch-hill, Ellerdale-road (from Prince Arthur-road to Arkwright-road), England-lane, Finchley-road (from Parsifal-road to Burrard-road), Fortune-green-lane (from West end-green to Parsifal-road), Frognal-rise, Haverstock-hill (from Belsize-grove to Eton-road), High-road, Kilburn (from southern boundary to Maygrove-road), Holly-hill, Inglewood-road, Lancaster-place, Parsifal-road, Prince Arthur-road, West-end-lane (from Gascony-avenue to West-end-green), West Heath-road (from Branch-hill to Redington-road). The Vestry are prepared to consider applications for the supply of the current in any of the other roads of the parish. The price charged for electricity during the night service—*i.e.*, from sunset to midnight—is 6d. per unit, and during light and day services, ranging from midnight to sunset (for which purpose special arrangements must be made), 4d. per unit. The bills of private consumers amounting to £25 and upwards per annum (for current only) will be subject to the following reductions—viz.:

Annual bill.	Reduction.
£25	3 per cent.
50	5 ,,
100	10 ,,
250	15 ,,
500 and over	20 ,,

The rebate will be made annually on the Christmas quarter's account. It is intended that a separate report shall be issued at Christmas, 1895, on the working of the station from the opening up to that time, and together with that report will be published the accounts of the electric lighting undertaking.

Stafford.—A correspondent writes: In a very few days upwards of a score of business places and dwelling-houses in Stafford will be lighted by the electric light from the current supplied from the Corporation electric station. The engines and boilers have been fixed and tried, the dynamos are in place, and will be run next week under the direction of a representative of the Electric Construction Corportion. The only missing link literally is the switchboard, by which the connection will be made from the dynamos to the cables. Of cables there have now been laid some 9,000 yards, if we include the service branches. Speaking broadly, the main cable runs the whole length of the main street of the borough from the newly-made spacious entrance to the electric station, near Messrs. Bostock's factory, as far as the new Baptist Chapel in course of erection at the entrance of the Lichfield-road, which itself is to be lighted by electricity. This main cable is tapped laterally, first to supply the county infirmary, which is to be lighted by electricity, then a branch is carried down Salter-street for the Vine Hotel. A cable also encircles the Market-square, branches down Market street, also by St. Martin's-place, and down Martin-street to the County Council Buildings, where the Corporation will have large consumers of their new product. Another branch cable stretches up St. Mary's-gate to the County Council Technical Instruction Buildings, supplying on the way the Conservative Club, which has already been wired, and is ready to take the new illuminant. Another feeder runs down Tipping-street to supply consumers there, and then the main, as we have said, continues along the principal thoroughfares. It is not proposed at present to undertake street-lighting, but as an experiment it is intended to erect one or two arc lamps in the Gaol-square when the electric station is opened on September 25. The present plant at the station, as now on the verge of completion, is capable of supplying 6,000 8-c p. lamps, all in use at one time. The present demand, as enumerated above, is for upwards of 2,000 such lamps. The system adopted here is the low-pressure continuous-current, with accumulators so that the engine power may be utilised during the day and the electricity stored in the accumulators and utilised at night. Thus the engines can be used during the day for the night supply. It will be satisfactory to every ratepayer in the borough to realise that the electric station is one that can almost be cited as a model for excellence in design and construction and the efficiency of the plant. The boiler and engine houses themselves are almost models of what such places should be The site of the buildings, which cover an area of 130ft. by 70ft, was a waste unsightly space between the gasworks and Messrs. Bostock's factory, and a wide and spacious approach has been secured from Foregate-street to the departmental office of the electric station. The head office of the combined gas and electricity departments of the Corporation, under the charge of the energetic manager, Mr. Bell, is, of course, at the existing gas offices. The three large boilers have been under steam some time now, and with the engines work admirably and smoothly. They are being covered with Leroy and Co.'s non-conducting composition to prevent the radiation of the heat from their large surface and from the steam-pipes, and the result is that the large and roomy house, 56ft. by 40ft., and proportionately high, is comparatively cool. Each boiler is 28ft. long, with a diameter of 7ft. 6in., and each is fitted with a patented breeze furnace, by which they can be made to consume the waste unsaleable fine coke. A jet of steam can be blown along a pipe under the furnace bars, developing a high forced draught, and great heat is main-

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tained from this waste fuel. The necessary slack is brought by a siding to the furnace doors, and the water runs from the river by a pipe to a cistern hard by, whence it is pumped to a purifying apparatus and fed to the boilers. The engine-house, where are the three engines and dynamos, is a fine building on a higher level under the same general roof of the whole block. It is built internally of white glazed brick, and there is a travelling crane capable of lifting 12 tons, by which the heavy parts of the engines can be lifted and dropped in their places. The flywheels, which run partly above the floor and partly below, are 12ft. 1in. in diameter, and deeply grooved with seven grooves to take the 1¼in. cotton ropes that will drive the pulleys on the dynamos. These ropes are being supplied through Mr. Jas. Macrea, engineer, of Stafford. The engines are compound, with high-pressure cylinders of 11in. diameter and low-pressure cylinders of 19in. diameter and with a 26in. stroke. They run very smoothly. They are fitted with Korting's jet condensers and Proell's automatic expansion valve gears. Each of them can be worked up to 150 h.p., but as a rule they will be run at their most economical load of 120 h.p. The iron floor plating necessary here in the floor along the ends of the engines, together with the exhaust mains, has been supplied by Messrs. Bagnall and Co, Limited. The engines standing on a higher floor than the level of the boiler-house, and being raised on massive brick buttresses, there is thus a kind of half cellar underneath them, and the dynamos and any part of the fixtures can be viewed at work from below as well as above. There is a roomy space of two-fifths of the whole area of the engine-house still available for fixing two other engines should any very great demand for the supply of electricity for lighting purposes in time arise, but the present installation will meet all requirements for some time to come. The boilers have been supplied by Messrs. Hick, Hargreaves, and Co., the engines by Messrs. Marshall, of Gainsborough, the dynamos by the Electric Construction Corporation, of Wolverhampton, and the cables by Messrs. Siemens and Co, of London. The Corporation put the foundation in themselves, and the building has been erected by Mr. Lovatt, of Wolverhampton The three boilers are of 1,000 h.p., and the three dynamos of 66 kilowatts each. The present installation, it is stated, is sufficient for any probable house demand and for the electric lighting of the main street. The switchboard, when erected next week, will separate an adjacent fitting shop from the engine-house. Above here, on the north side, and approached by steps from the new entrance from Foregate-street, is the battery-room, where are 112 accumulator cells, supplied by the Chloride Electrical Storage Syndicate. These have to be maintained in working order by that company for three years, under their contract with the Corporation. Here the electricity generated during the day will be conserved for use at night, when the engines are stopped. Adjacent, on the other side of the landing, is the office of the electric works, where the head electrician and his assistant will be in attendance, and where fittings and electric lighting appliances can be seen and ordered. On the occasion of the laying of the memorial stone in the electric station in October last year by the then Mayor (Mr. G. Wormal), Alderman W. H. Peach, the chairman of the Gas and Electric Lighting Committee, expressed the hope that the whole work would be carried out without any accident to the lives or limbs of those employed upon them. This hope has been realised, and that it has been so is not the least satisfactory feature of an undertaking that has apparently been so admirably carried out with credit to all concerned. The committee, in view of the completion of the works for the provision of electric light to the town, have appointed a sub-committee to make all necessary arrangements for a public opening ceremony of the works on September 25.

PROVISIONAL PATENTS, 1895.

AUGUST 26.

16008. **An improved telephonic instrument designed for use on poorly-insulated lines, such as the existing wires of an ordinary wire fence.** Gustaf Dillberg and Parnell Rabbidge, 40, Chancery-lane, London. (Complete specification.)

16019. **Improvements in connection with incandescent electric lamps and their holders and fittings.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (Alfred Swan, United States.)

AUGUST 27.

16022. **An improved form of cell for primary or secondary electric batteries.** Edward Burnet and Frederick Foy Smith, the Grammar School, Park-lane, near Wigan.

16042. **A compound electrical testing switch.** Howard Dudley Norman, 69, Brunswick-place, Brighton.

16077. **Improvements in electromagnetic tools.** William Phillips Thompson, 31, High Holborn, London. (Abraham George Fonda, United States.) (Complete specification.)

AUGUST 28.

16173. **A switch formed as a handle in which electric circuit is completed by the automatic fall of a piece of solid metal contained within the handle.** Charles Solomon Newman, 13, Pembridge-crescent, London.

AUGUST 29.

16218. **Improvements in electrical fire and burglar alarms.** John Ronald Shearer, 28, Southampton-buildings, Chancery-lane, London.

16247. **Improvements in or connected with electric cables or conductors.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

16248. **Improvements in electric transformers and dynamo armatures.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

AUGUST 30.

16275. **Improvements in instruments for making electrical and magnetic measurements.** James Finlayson, 62, St. Vincent-street, Glasgow.

16287. **Improvements in dynamo-electric machines and motors.** Louis Hallé, 18, Buckingham-street, Strand, London. (Complete specification.)

AUGUST 31.

16350. **Improvements in or relating to electric batteries.** Alfred Julius Boult, 323, High Holborn, London. (E. A. Wunderlich, Germany.)

SPECIFICATIONS PUBLISHED.

1894.

14988. **Electrolytic cells.** Wise. (Solvay.)

15219 **Telephonic, etc., lines.** Müller.

16162. **Secondary batteries.** Engl.

17066. **Electric cables.** De Ferranti.

17737. **Electric cables.** Nisbett.

18809. **Secondary batteries.** King.

21045. **Dynamo-electric machines.** Hutin and Leblanc.

24615. **Lightning arresters.** Blackmore and Carlin.

1895.

4873. **Electrical insulating materials.** T. P. and G. H. Wiggins.

12469. **Electric railway vehicles.** Müller.

12772. **Electric circuits.** Rowand.

12836. **Electric cut-outs.** Dorman and Smith.

12953. **Chloride of lead.** Chloride Electrical Storage Syndicate, Limited, and Rhodin.

12954. **Secondary batteries.** Chloride Electrical Storage Syndicate, Limited, and Grindle.

13207. **Arc lamps.** Seibold and others.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¼-5⅜
Brush Company, Ordinary	3	1⅞-2⅛
—— Nom. Cum., 6 per cent. Pref.	2	1⅞-2⅛
—— 4½ per cent. Debenture Stock	100	111-114 xd
Charing Cross and Strand	5	5¼-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6⅞-7⅛
City of London, Ordinary	10	15-15½
—— 6 per cent. Cumulative Pref.	10	15½-16¼
—— 5 per cent. Debenture Stock	100	132-135
City and South London Railway, Consolidated Ordinary	100	38-40
—— 4 per cent. Debenture Stock	100	134-126
—— 5 per cent. Pref. Shares	10	14½-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1-2
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A 1-200 of £50	100	—
Electric Construction, Limited	2	⅛-¼
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	2-2½
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	¾-1⅛
Fowler-Waring Cables	5	2-3
W. T. Henley's Telegraph Works, Ordinary	10	11½-11⅝
—— 7 per cent. Preference	10	15-15½
—— 4½ per cent. Debentures	100	104-107 xd
House-to-House Company, Ordinary	5	3½-4
—— 7 per cent. Preference	5	7⅛-7½
India Rubber and Gutta Percha Works	10	19-21
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅞-8⅛
—— Pref.	—	—
Liverpool Overhead Railway	10	11-11½
—— 5 per cent. Pref.	10	15-15½
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	½-¾
Metropolitan Electric Supply	10	12-12½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-119
National Telephone, Ordinary	5	6-6½
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Non. Cum. Third Pref	5	6-6½
—— 3½ per cent. Deb. Stock	100	106-108
Notting Hill Company	10	8½-9½
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	5	7½-7⅞
—— £4½ shares	4½	6-6½
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8½-8⅝
—— 7 per cent. Pref.	5	9-10
Swan United Ordinary	3	2-2½
—— 4½ per cent. Debentures	100	104-107
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4½-4¾
Westminster Electric Supply, Ordinary	5	8½-9
Yorkshire House-to-House	5	5¼-5⅜

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NOTES.

The Telephone in Japan.—It is said that Tokio has six telephonic exchanges, Osaka three, and Yokohama and Kobe two each, and that the cost to subscribers is about £9 a year.

The Electric Light in Ceylon.—There is apparently a great demand for the electric light in Colombo for both private and public purposes, and the local firm of electrical engineers is said to have its books full of orders. "When," asks an Indian correspondent, "is Calcutta going to begin in earnest?"

The Electric Furnace.—A new claimant for priority in the application of the electric furnace to the working of refractory metals and to the production of calcium carbide has, it appears, come upon the scene in the person of Dr. Torres, a French chemist. Dr. Torres claims that he put his ideas in this direction into practice months before either Moissan or Willson did.

Electric Traction in Italy.—The Italian Society for the Promotion of Light Railway Construction (L'Unione delle ferrovie italiane di interesse locale) has, *Elettricità* of September 8 says, drawn up a memorial to the Minister of Public Works praying for a modification of the existing laws governing the building and working of secondary railways with a view to the application of electric traction.

A Telegraph Office on the Atlantic.—The Commercial Cable Company has established, in connection with the international yacht race, a telegraph office on the Atlantic Ocean. It has stationed its steamer, the "Mackay-Bennett," at the point where the "Defender" and the "Valkyrie" begin their contests, and has connected the vessel with Great Britain and France by its main ocean cables.

Telephony and Telegraphy in Spain.—*El Telegrafista Español* announces the opening for public use by the Compañia Telefónica Interurbana of its telephone station in Bilbao, which has now direct communication with San Sebastian, Vittoria, and Durango. The same journal reports the publication of "El Catálogo general de las Estaciones Telegráficas de la Península Española," being a register of telegraph offices in Spain.

The Electric Light in Russia.—The municipal authorities of Warsaw have elaborated a project for the grant of a concession to electrically light the whole of their city. There are required 233 1,000-c.p. arc lamps and 5,140 incandescent lamps. Contractors have to deposit 125,000 roubles upon announcing their resolution to tender for the installation, while a successful offer involves the deposit of a further sum of 125,000 roubles. The concession will be valid for a period of 35 years.

Light Railways.—The Bishop of Chester appeals for State aid for the purpose of constructing a light railway in Cardiganshire. The line would, he says, develop the resources of the district by finding for its farm produce and for the fish which is plentiful in Cardigan Bay a ready market among the swarming industrial population of Glamorganshire and Monmouthshire; would bring back coal, lime, and other supplies, and would open up and render accessible some delightful bathing places on the coast.

Glasgow - London Telegraphy. — The Glasgow Chamber of Commerce at their last meeting authorised the Home Affairs Committee to petition the Postmaster-General regarding the time taken in telegraphing between Glasgow and London. The members had provided themselves with batches of telegrams which showed that the average time occupied in despatching messages over the Post Office wires between the two cities was 30 minutes and the longest 65 minutes. It is stated that the Glasgow Royal Exchange is framing a similar petition.

A New Game.—Philadelphia youngsters have devised a delightful game which they call "Trolley Car." It is played by from two to twenty juveniles, all but one of whom sprawl on the pavement, while this selected one trundles a baby carriage over them. In Chicago a rather different view of the matter is taken. The following so-called epigram from the *Daily Tribune* is there very popular:

"As to the trolley wires,
It has been found
Cheaper to put the people
Under the ground."

The Electric Light in China.—Haiphong, we are told, has now electric light in its streets, like Hongkong, and has also its "Chinaman who ceaselessly climbs to the top of the lamp-posts with a hammer and chisel in one hand and a coil of wire in the other." But the Haiphong acrobatic wireman, we are further informed, is not so nimble as his colleague in Hongkong, who never seems to miss his footing. The French colony has only had the electric light for a few weeks, but an accident has already occurred, a man falling from the top of a standard with fatal results.

Canadian Canals and Electricity.—St. Mary's Canal, the new Canadian waterway connecting Lakes Superior and Huron, has just been opened for traffic. The lock measures 900ft. by 60ft., and is 20ft. deep. The gates and valves are worked by electricity. The construction of the canal, which has cost £750,000, gives Canada an independent waterway from the head of Lake Superior to the ocean. The American engineers engaged in cutting the canal on the Michigan side of the river telegraphed their congratulations to the Government on the successful inauguration of this magnificent undertaking.

Telegraphy in Argentina.—Construction work on the telegraph line from Bahia-Blanca to Mar del Plata is so far advanced that Mr. Segovia, the engineer, has his tents now pitched on the farms near Necochea. The work is for the account of the National Government, and the telegraphic stations will be Monte Hermoso, La Sirena, El Cristiano, Necochea, and Mar del Plata, while there will be a branch line from El Cristiano to Tres Arropos, with an intermediate station at San Jorge. The service was, it appears, so badly wanted that the neighbouring estancieros patriotically subscribed upwards of 9,000dol. towards the cost.

Horses v. Electricity.—An enthusiastic correspondent writes: "Horse haulage will soon be a thing of the past in Glasgow. A strong sub committee of the Corporation Tramway Committee has been appointed to enquire into the application of mechanical or electric motors to tramway cars, and there can be no doubt that the result of its investigations will be that the horse will be superseded. Perhaps when that day comes there will be a realisation of the dream of the city artisan being whirled away out into the suburbs, when the city will be given over entirely to commerce, and everybody will stay in pretty little cottages in the country." Details will be found in our "Business Notes."

The Electric Light in Argentina.—The Mayor of Buenos Ayres has forwarded to the City Council a proposal for the establishment of three electric light stations in Calles 60 A, Cordoba, and Caseros, for lighting the streets. The cost of the installation is estimated at 346,929dol. gold and 125,280dol. national money. The Public

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Works Committee has, however, disapproved of the scheme, and proposed that the director of public lighting be sent to Europe and the United States in order to investigate and study the systems of electric street-lighting in vogue in the various cities there. The Committee of Interpretation, on the other hand, is of opinion that the Mayor's proposition should be confirmed.

Electricity and Mining. — The latest indication that the connection between the mining industry and electricity is gradually drawing closer is the fact that the Westralia Mining Company, Limited, has acquired the concession for the exclusive right of furnishing electric light to the municipality of Coolgardie for the term of 21 years. This concession it has, in turn, sold to the Westralian Electric Lighting and Supply Company, Limited, which has been formed with a capital of £80,000, in £1 shares, of which £35,000 are working capital. It is possible that the dreary mushroom town of Coolgardie, where so-called fresh water costs about a shilling a gallon, may have the electric light before the railway touches the "municipality."

Charterhouse Science and Art Schools and Literary Institute.—The winter session of this institution, one of the largest science and art schools in the United Kingdom, will commence on Saturday, September 28, under the presidency of the Rev. Henry Swann, M.A. During the late session upwards of 1,200 students, mostly elementary teachers, availed themselves of the privileges afforded by this institution, and of this number 682 presented themselves for examination, and were successful in obtaining a large number of certificates awarded by the Science and Art Department of South Kensington. Several students prepared for the Lond. B.Sc. (Int.) examination. Instruction of a practical character is given in most of the sciences at a very nominal fee, whilst in art at an equally low rate students under the direction of competent instructors can be advanced in their studies.

Electric Traction in Germany.—Some further particulars are published in the *Elektrotechnischer Anzeiger* of September 8 of the tour which a deputation from the Berlin Town Council made in order to study the method of street locomotion adopted in various towns. Visits were paid to Dresden, Dessau, Hagen, Frankfurt-a.-M., Strassburg, Paris, London, Liverpool, Glasgow, Edinburgh, Rotterdam, The Hague, Amsterdam, and Brussels. The deputation state that underground railways, like those in Paris, London, Glasgow, and Liverpool, could not very well be built in Berlin, owing to the floating-sand strata, and they recommend that experiments be made, as far as possible on existing horse lines, with the overhead conductor, the Klette (Dresden)—the lead—accumulator, the gas motor, and the Serpollet (steam) system. The first electric tramway in Berlin was, by the way, opened to public traffic on Tuesday.

"Strassenbahnwagenuntergestelle." — A short time since the English and American technical Press waxed funny over this compound German word, and now the *Elektrotechnische Zeitschrift* has its say on the matter. "Some time ago," it remarks, "English and American technical journals gave a humorous explanation of the word 'Strassenbahnwagenuntergestelle,' which corresponds to the English word 'truck.' These two words are in a certain sense characteristic of the two languages: a German combines words with each other and obtains a word which, though long, can be understood by one who has never heard it before; the Englishman creates new words for new things, or he uses well-known words with a new meaning." But to say that the German monstrosity corresponds to "truck" is scarcely correct. It is literally "street railway car underframe," which cannot really be compressed into anything less than "street-car underframe" or "tramcar underframe."

Signs of the Times.—The advance which is being made towards the universal adoption of electricity as an illuminant is nowhere, a correspondent writes, more noticeable than in Staffordshire. It is not to be wondered at that the county town, with its central situation and numerous advantages over places of greater extent and population, should be anxious to keep well abreast of the times in this respect, and, in point of fact, the Corporation electricity supply will be ready for use by the end of the month—about the same time that the new light will be introduced at Walsall. A more remarkable portent of the times is that the small country town of Cheadle, and the still less known district of Alsager, on the northern borders of this county, should have at present under consideration the adoption of the electric light; while the Rugeley Urban District Council have signified their intention of taking into consideration the lighting of the streets by electricity.

"Hyde Park at Night."—One of the discussers of this unsavoury subject in the daily Press—Mr. E. J. Watherston—makes a practical suggestion. He says: "The state of this park after dark is known to all who have the misfortune to make a short cut across it after nightfall. The reason is simple: it is not lighted. Applications have been made over and over again to the proper authorities, but, although we are spending imperially one hundred millions per annum, there is no money forthcoming to light up Hyde Park. And yet it is open to the public until, I believe, 12.30 a.m. The electric light well placed and well distributed would alter the conditions of the place half an hour after lighting up, and for ever. Let us hope that, now public attention and indignation have been aroused, her Majesty's Office of Works, which has done so much for the improvement of all the Royal parks, may immediately, even without waiting for a supplementary vote in Supply, give the necessary instructions for lighting Hyde Park in such a way as to prevent any recurrence of the evil complained of." We can only interject, in sympathy with the correspondent's views, *Fiat lux!*

Electrical Potentials in a Liquid Conductor in Uniform Movement.—Mr. G. Gouré de Villemontée, in *Comptes Rendus*, deals with this subject. Mercury, and solutions of zinc, copper, and nickel sulphates containing 10 grams of the salt per litre, were caused to move through insulated horizontal or vertical glass tubes of uniform bore, the diameter being 3mm. for mercury and 8mm. for the saline solutions, and observations were made with a view to detect differences of potential between two points in the liquid. The capillary electrometer used would indicate a difference of 0·00015 volt. The electrodes consisted of platinum wires, the ends of which were coated with an electrolytic deposit of the metal contained in the saline solution. Sometimes both electrodes were in the path of the moving liquid, sometimes one was in the moving liquid and the other in the reservoir. The rate of movement of the liquids was 33·5mm. per second in the horizontal tubes and 155·3mm. to 323mm. in the vertical tubes. The results show that the uniform movement of a liquid conductor along wide insulated glass tubes of uniform section produces no appreciable difference of potential between two points of the liquid within the limits of velocity specified.

Horseless Carriages.—In view of the exhibition which he proposes to hold during next month if the horseless carriages which are being specially constructed to his order in Paris be then completed, Sir David Salomons

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has published some remarks in favour of the employment of steam, petroleum, and electric carriages or wagons by farmers and others, as against light railways, which he believes would not pay; or road trains, which would soon render the roads useless for any other traffic. In his opinion the Acts of Parliament regulating the use of locomotives on roads do not forbid the employment of self-contained and self-propelling carriages, which did not exist when the Act was framed, but the ordinary statutes make all necessary provision for the regulation of such locomotion to avoid danger or nuisance. Sir David speaks in praise of the French system of "voitures automobiles," and adds that a Frenchman looks at him with incredulity when told that there is no similar system in England. It is a disgrace, Sir David says, that a great engineering nation, which was the pioneer of railways, should be the only spot in Europe where such a state of things exists. The question has never been carried to the higher courts as to whether such vehicles may or may not be used, but simply rests on a magistrate's decision that a bicycle is a traction engine if propelled by other than animal power!

Personal.—In order to show their appreciation of the able manner in which Alderman Lennard, as chairman, has for a number of years presided over their deliberations, and more especially of his services in connection with the electric light installation, the members of the Gas and Electric Lighting Committee of the Corporation of Leicester decided to make him a presentation in the form of an album containing the photographs of the members of the committee, and to include Mrs. Lennard in the tribute. It was intended to make this presentation at the time of the celebration of the installation of the electric light, but some delay took place in obtaining the photographs, and thus the matter was postponed. The album being now complete, Alderman and Mrs. Lennard were invited to a tea party in the recreation and reading room of the gasworks on Thursday last week, in order that they might receive it. On the outside of the cover were the initials of the worthy alderman and his wife, and the flyleaf bore the following illuminated inscription: "This album was presented to Alderman Lennard, chairman of the Corporation Electric Lighting Committee, by his colleagues, as a souvenir of the inauguration of the Leicester Corporation electric lighting works, and also as an expression of the high appreciation of his valuable services in connection with the department over which he has presided for the past six and a half years." This was signed by the whole of the members of the committee and the engineer, Mr. A. Colson.

The Electrical Effects of the Last Storm.—Mr. M. Williams, of Hyde Park Court, Albert-gate, S.W., seems to be nothing if he is not tempestuously daring. He writes: As witnessed from the top of this lofty, prominent building, the local electrical and atmospheric effects of the thunderstorm of September 7 were exceptionally striking. On account of its situation and structure this building may readily be expected to lend itself to manifestations of electrical discharge under the exceptional atmospheric conditions that prevailed. The north side directly faces the great open space of Hyde Park, and the various blocks are capped by high pointed towers, which rise to a height of some 130ft., far above all surrounding buildings. There is also a large mass of exposed metalwork, such as pipes, metal roofing, and a network of large iron flues, which are connected to some 80 chimneys, being used for artificial draught and operated by an electric fan fixed on the roof. In addition to this, an iron spiral outdoor staircase runs up nearly the whole of the building. Lightning-conductors formed of a network of copper strip are well connected to earth, and also to the water-pipes and metalwork on the roof. The storm seemed to approach with great rapidity, and the top of the building for fully half-an-hour was enveloped in a curious mist, or rather a luminous vibrating glow, having much the same effect as that produced in Mr. Tesla's beautiful experiments with high-tension alternating currents of high frequency at the Royal Institution. The turrets and other portions of the roof forming the sky-line seemed to give forth streams of light, while at rapid intervals bunches of thin riband-like lightning darted from the luminous mist to various exposed points of the roof, and nearly always apparently in an upward direction. During this period there were no loud thunder claps, but a succession of crisp trembling detonations as from a Wimshurst machine. The only sensation I experienced whilst standing either on the metal roofing or iron staircase was a pleasant exhilarating sensation accompanied by the distinct smell of ozone, as in the Tesla experiments. As the storm passed over the usual heavy flashes and thunder claps commenced. I observed two exceptionally heavy lightning discharges in a southerly direction, which appeared likely to have produced local damage. The panorama of London illuminated under the above conditions was beautiful in the extreme.

Lightning-Conductors on Ships.—Mr. C. Tomlinson, F.R.S., says that in 1866 he described a method of receiving the discharge of a Leyden jar on a plate of crown glass. "Supposing," he adds, "such a discharge to represent in miniature a lightning discharge, we have a tree-like figure with trunk, branches, and spray, and in some cases bifurcations and even trifurcations. About this time lightning-conductors were not in favour either on land or sea. When the new buildings of the Cholmeley School, Highgate, were being erected, the then headmaster, Dr. Dyne, consulted me as to the desirability of a lightning-conductor, and asked me to see the architect on the subject. That gentleman assured me that he had never erected a lightning-conductor, and did not know how; that his profession regarded conductors as attracting lightning to the place instead of repelling it. A similar opinion was held at the Admiralty. Snow Harris had strenuously recommended his metallic conductors for ships, and had abundantly proved what important losses had occurred through their absence. He had obtained permission to erect his conductors on ten ships destined for foreign service, and in one of them a flagstaff had been put up above the conductors, and was consequently shattered by a lightning stroke, but no further damage was done. This trifling accident seemed to justify the order for the removal of the conductors from each ship on its return home. But at Devonport a bifurcated discharge occurred which had most singular results. Sir John Rennie was employed by the Admiralty to erect two victualling houses at Devonport. Each was furnished with a granite chimney rising 60ft. above the roof. One of these was furnished with a lightning-conductor; but before the other was erected Rennie called on Snow Harris with the indignant complaint that the charge for lightning-conductors had been struck out of the estimates. Harris said, 'Well, never mind, Nature will avenge us!' Never was prophecy more amply fulfilled. A bifurcated stroke of lightning fell on the two victualling houses; the protected building suffered no injury, the unprotected chimney was torn open, with other damage to the building, to the admiration of the British Association, which met at Plymouth that same year—namely, 1841. This fortunate bifurcation at once made lightning-conductors popular. Harris's admirable arrangements for ships were in due time adopted, to the immense advantage

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of the Navy. Harris was knighted, received a Civil List pension of £200 a year, and lastly the House of Commons, on the motion of Lord Palmerston, made Harris a grant of £6,000 for his invention, the noble mover stating that he never made a similar motion with greater pleasure." Since the Navy has been thus protected, Mr. Tomlinson does not remember hearing of the slightest damage being done to any of her Majesty's ships.

The Pacific Cable.—Some particulars as to the progress made by American promoters of a Pacific cable are to hand. Colonel Z. S. Spalding, the projector of the new cable to connect the Hawaiian islands and to place Honolulu and San Francisco in direct telegraphic communication, has appeared before the trustees of the Chamber of Commerce of 'Frisco to explain to them in detail what he has thus far accomplished, and consult them as to the steps now to be taken to secure the co-operation of the United States in the undertaking of which he is the promoter. Mr. Sanford Ballard Dole, it appears, signed the agreement with Colonel Spalding on August 12. By it the latter is granted an exclusive franchise for 20 years from November 1, 1895, "to construct and land upon the shores of the Hawaiian group, a submarine electric telegraph cable, or cables, to or from any point or points on the North American continent, or any island or islands contiguous thereto." It is, however, stipulated that the first cable have its terminus in San Francisco, and it is for the maintenance of this that the subsidy will be paid by the Hawaiian Government for 20 years. The amount of the subsidy is to be 40,000dol. a year from the date of the establishment of telegraphic communication between Honolulu and San Francisco and between Honolulu and the islands of Hawaii, Maui, Molokai, and Kauai. The agreement is hedged with further conditions, among them being one that the work of construction shall commence on or before May 1, 1897, and another that telegraphic communication shall be established not later than November, 1898. Yet another is that the Government of the United States shall join in the undertaking "by the grant of substantial assistance to the contractor." If this assistance were not granted, or should the contractor fail to comply with the conditions of the agreement, then the Hawaiian Government, it is stated, will have the right of cancelling the contract 60 days after service upon the banking house of Bishop and Co. at Honolulu of a notice of its intention so to do. A free right of way across all Government lands and exemption from duty on all materials and from taxes and port charges is granted to the contractor for 20 years, as well as the privilege of condemning and appropriating such property or rights of way as may be necessary for the operation of the cable. If the Government should desire to assume control and ownership of the interisland lines at the end of one year after the completion of the system, it reserves the right to do so on payment of the cash cost of the land, stations, lines, and equipments free of all encumbrances and liens for bonds or interest on bonds. The contract, moreover, specifies that Press messages shall be carried at a rate not to exceed half of the regular rates charged, and Government messages up to the cost of the annual subsidy must be carried free. The promoter is, finally, required to give bonds to the amount of 25,000dol. for the faithful fulfilment of his contract.

Electric Traction in India.—The Madras electric tramway question is still a fertile theme of discussion in the Indian technical Press. "Generally speaking," says a work on "Electric Traction," "it may be laid down that the underground conduit system requires for its successful working (1) sufficient traffic to warrant the extra expenditure involved in the construction and maintenance of a conduit; (2) an ample depth in the street for a conduit of sufficient capacity to prevent flooding; and (3) good and efficient drainage." In adopting the conduit system in Madras the last two considerations, a correspondent observes, were evidently lost sight of, or it was thought they could be surmounted. However this may be, the overhead is about to be substituted for the present conduit system, and, from all accounts, it is a much more simple system of traction than the conduit, while in initial cost and maintenance it is appreciably cheaper. Another advantage in the overhead system is that the conductors, insulators, etc., are all above ground, and a glance is sufficient to detect anything wrong, while repairs can be made easily and without any delay. In America, where the overhead system has generally been adopted, there are over 1,000 miles of electric tramways laid down, representing a capital of £50,000,000. The machinery now used in Madras is of the very latest description; and is, for the present, under the management and supervision of Mr. Gadsby, a Whitworth scholar and an electrical engineer of considerable attainments. The power-house and workshops at Egmore are worth a visit. Two dynamos are working—one only is used at a time—alternately from 6 a.m. to 8.30 p.m. Each dynamo is built for 240 amperes at a pressure of 500 volts, and is capable of driving 20 cars at a speed of 15 miles an hour; but for the present only a pressure of 350 volts is required, and an average speed of about eight miles an hour is maintained. The engine-house contains two high-pressure engines fitted with Corliss's valve gear, and wood is used as fuel, 4½ tons being necessary daily for the seven cars at work. The local tramway cars began working in the early part of May, and although only seven cars have been running on one section of the line from the Custom House to Egmore, the earnings are fairly remunerative, and the trustees of the debenture-holders consider that they have no reason to be dissatisfied. The section from the Custom House to Egmore, being a double line, represents a distance of 5½ miles. There are two more sections under construction, about three miles and 1¼ mile long respectively. Accurate information as to the earnings, the number of passengers carried, etc., up to date is not available at present, but the trustees think that the three sections will cost, and can be worked at, little more than one. There is, the correspondent adds, room for improvement in regard to lessening the noise made by the cars, in respect of the uniforms of the conductors, ticket examiners, and drivers, and especially in the direction of making passengers more comfortable. An improved style of car is, however, being designed. As soon as sections 2 and 3 are equipped on the overhead system, the present conduit system in force on No. 1 section will be abandoned for the overhead system.

Electric Street-Lighting.—Mr. George Cutter, in a paper read before the North-Western Electrical Association at Chicago, said that in considering a question like that of lighting streets, alleys, and public squares, we should first define the results to be produced by the lighting system. It appears quite simple to define the theoretically perfect lighting, but it is not as easy to decide which system gives results nearest to the theoretical; local conditions affect this question more or less. A general uniform illumination of mild intensity, such as that of a dark cloudy day or possibly that of a clear night with a full moon, is the theoretical condition to be produced by artificial lighting. This is especially the case after bedtime. But for proper results we must produce a brilliant illumination of the business centre until bedtime, and for the sake of econ omy we must then change the down-town illumina-

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tion to the same mild intensity that serves for the residence districts earlier in the evening. There is one important factor in street-lighting which might modify our practice in regard to the best general illumination. It is the police duty of the light in preventing crime and in facilitating the capture of criminals. But even for this duty a uniform illumination of mild intensity is likely to prove best, because the eye which is adjusted to a bright light cannot distinguish objects in a dull light. There are various points to be considered when we come to the practical side of the question and try to determine what system will give the best approach to the theoretical results with the fewest practical objections. Among these points I might mention a few of the most important: (1) We should consider the means of distribution to produce the nearest to our theoretical conditions—that is, we should aim to procure a uniformity of light, even of mild intensity, in preference to a few extra bright spots with intervening dark spots. An exception can be made, as before indicated, for the business section before bedtime, a brilliant illumination of this section in the early part of the night changing to correspond with the rest of the city for the rest of the night. (2) Reliability of service of the lighting system, since it loses its effectiveness either as a safeguard as a path-finder, or unless it is perfectly reliable. (3) Steadiness of illumination is another point closely connected in importance to the one just mentioned, and in the same line of thought—viz., that of avoiding contrasts in illumination either in different localities or at different times. Determining the last two points brings us to the fourth: necessary skill of all labour and ease of procuring same, the employment of home talent to the greatest extent possible being usually advisable. If the installation and operation of our plant requires special skill, then absence of this skill might cause bad service, or even total cessation of light. Then there is the durability of the apparatus, together with ease and economy of replacing used-up parts. In considering this we must look out for both the probability of permanency of the supply of duplicate parts, and the amount of attention to keep all in good working shape. After careful judging of the closely related points thus far enumerated, we can well give attention to the sixth: efficiency of conversion from coal pile to light. My only comment on this point is that I place it second in importance to that of general uniform illumination, as high efficiency can well be set aside for the other more desirable feature of uniformity. Considerations of this point of efficiency leads to the seventh—total operating expenses—the importance of which depends almost entirely upon local conditions; as also the eighth point: cost of necessary plant for producing the light. This leads to the ninth: appearance of fixtures on streets and squares, and on this point more attention should be given than is the usual practice. A large share of the opposition to overhead wiring would never have been raised if it had not been for the bungling work which is so common.

Double Swing-Bridge Operated by Electrical Power.—Among drawbridges that have recently been constructed, the one which spans the Cuyahoga River at Columbus-street, Cleveland, Ohio, has attracted an unusual amount of attention on account of several novel features which have been introduced into its design and method of operation. It was built to replace an old swing-bridge with a centre pier, which was a serious obstruction to traffic on account of a sharp bend in the river at this point and the narrow passage allowed for vessels on each side of the pier. It was also necessary to build the abutment farther back at one end to make way for the tracks of a railroad company, which owned the right of way. To meet all the requirements in the most satisfactory manner and at the least expense, the city engineer, Mr. Walter P. Rice, designed a double swing-bridge. Briefly described, this bridge consists of two independent swing spans, mounted upon piers on each side of the channel of the river, thus leaving a clear space for navigation between the protections of the piers of 121ft. These spans are identical in construction, being 139½ft. long, and forming, when the bridge is closed, a continuous roadway of 279ft. from abutment to abutment and 20ft. wide between wheel guards, with a sidewalk 6ft. in width on each side. The bridge is built on a grade, the south end being 8ft. higher than the north. This is accomplished by a difference in the heights of the bearings for the loading beams, thus allowing the drum to turn in a horizontal plane. The structure is of special interest from the fact that it is operated by electricity, and all auxiliary motions are accomplished by compressed air, the compressor being driven by an electric motor. There being two spans, the bridge is really operated by two entirely independent electric plants, duplicates of each other. The current is brought to the bridge by separate lines from two different street railway circuits, and is brought to the junction-box at the top of the south pier by lead-covered cables protected by an iron conduit. From the junction-box the mains are run through a duct leading from the outside of the masonry of the pier to the hollow centre casting about which the drum turns, and are connected with stranded conductors which lead to the floor of the bridge above, whence the cables continue to the main switch in the operating-house. All the wires used about the bridge are lead covered with the exception of the connection between the fixed centre casting and the flooring of the bridge which turns. This of necessity must be flexible, that it may not be injured by the motion of the bridge in moving through an angle of 90deg. in either direction and back. For protection from moisture and mechanical injury, the flexible conductors are enclosed in heavy rubber tubing. A double-throw switch in the operator's house enables current to be taken for the bridge from either power circuit. Duplicate iron-armoured submarine cables connect with the operating-house on the opposite span, and double-throw switches allow the spare cable to be thrown in if any trouble develops in the one in use. The drum of each span is revolved by means of the usual rack and pinion. A 25-h.p. Westinghouse waterproof multipolar railway motor is attached to the horizontal driving shaft. The controllers used were designed especially for this plant, and are exceedingly simple and compact, the resistance being located beneath the floor. No reversing switch is required, a forward or backward motion of the lever giving a corresponding motion to the bridge. This controller gives the bridge a noticeably smooth start, and there is an entire absence of the arcing common in 500 volt work. Each span is provided with an automatic switch which opens the circuit in case, through carelessness or from any other cause, the bridge swings beyond 90deg. In the south operating-house is an air-compressor, which is driven by a 5-h.p. slow-speed Westinghouse motor, and which pumps into the receivers beneath the floor of the bridge. These receivers are also connected with a similar set on the other span by means of a heavy lead pipe laid under the river. The connection between the fixed and movable parts of the bridge is made by means of flexible steam hose. The compressed air is used for operating the locks at the shore end of each span and the plungers and apron at the centre. The bridge is described and illustrated in detail by our Chicago contemporary, *The Western Electrician*, of August 24.

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THE BRITISH ASSOCIATION AT IPSWICH.

The sixty-fifth annual meeting of the British Association for the Advancement of Science commenced at Ipswich on Wednesday, under the presidency of Sir Douglas Galton, who, in the absence of the retiring president, the Marquis of Salisbury, was introduced to the meeting by Lord Kelvin. Up to Wednesday evening nearly 1,200 tickets had been issued. An unfortunate incident marked the reading of the presidential address. The Public Hall was lighted by gas, and the room grew very hot shortly after Sir Douglas rose. He appeared to be affected by the vitiated atmosphere from the first, and about the middle of his speech he broke done, and Sir J. Evans continued the reading of the address. Sir Douglas, however, sufficiently recovered to acknowledge the vote of thanks accorded to him for his address, which was as follows:

Presidential Address

BY SIR DOUGLAS GALTON, K.C.B., D.C.L., F.R.S.

My first duty is to convey to you, Mr. Mayor, and to the inhabitants of Ipswich, the thanks of the British Association for your hospitable invitation to hold our sixty-fifth meeting in your ancient town, and thus to recall the agreeable memories of the similar favour which your predecessors conferred on the association 44 years ago.

In the next place, I feel it my duty to say a few words on the great loss which science has recently sustained—the death of the Right Hon. Thomas Henry Huxley. It is unnecessary for me to enlarge, in the presence of so many to whom his personality was known, upon his charm in social and domestic life; but upon the debt which the association owes to him for the assistance which he rendered in the promotion of science I cannot well be silent. Huxley was pre-eminently qualified to assist in sweeping away the obstruction by dogmatic authority, which in the early days of the association fettered progress in certain branches of science. For, whilst he was an eminent leader in biological research, his intellectual power, his original and intrepid mind, his vigorous and masculine English, made him a writer who explained the deepest subject with transparent clearness. And as a speaker his lucid and forcible style was adorned with ample and effective illustration in the lecture-room; and his energy and wealth of argument in a more public arena largely helped to win the battle of evolution, and to secure for us the right to discuss questions of religion and science without fear and without favour. It may, I think, interest you to learn that Huxley first made the acquaintance of Tyndall at the meeting of the association held in this town in 1851.

About 46 years ago I first began to attend the meetings of the British Association, and I was elected one of your general secretaries about 25 years ago. It is not unfitting, therefore, that I should recall to your minds the conditions under which science was pursued at the formation of the association, as well as the very remarkable position which the association has occupied in relation to science in this country. Between the end of the sixteenth century and the early part of the present century several societies had been created to develop various branches of science. Some of these societies were established in London, and others in important provincial centres. In 1831, in the absence of railways, communication between different parts of the country was slow and difficult. Science was therefore localised; and, in addition to the universities in England, Scotland, and Ireland, the towns of Birmingham, Manchester, Plymouth, and York each maintained an important nucleus of scientific research.

Origin of the British Association.

Under these social conditions the British Association was founded in September, 1831. The general idea of its formation was derived from a migratory society which had been previously formed in Germany; but whilst the German society met for the special occasion on which it was summoned, and then dissolved, the basis of the British Association was continuity. The objects of the founders of the British Association were enunciated in their earliest rules to be: "To give a stronger impulse and a more systematic direction to scientific enquiry; to promote the intercourse of those who cultivated science in different parts of the British Empire with one another, and with foreign philosophers; to obtain a more general attention to the objects of science, and a removal of any disadvantages of a public kind which impede its progress." Thus the British Association for the Advancement of Science based its utility upon the opportunity it afforded for combination.

The first meeting of the association was held at York with 353 members. As an evidence of the want which the association supplied, it may be mentioned that at the second meeting, which was held at Oxford, the number of members was 435. The third meeting, at Cambridge, numbered over 900 members, and at the meeting at Edinburgh in 1834 there were present 1,298 members. At its third meeting, which was held at Cambridge in 1833, the association, through the influence it had already acquired, induced the Government to grant a sum of £500 for the reduction of the astronomical observations of Baily; and at the same meeting the General Committee commenced to appropriate to scientific research the surplus from the subscriptions of its members. The committees on each branch of science were desired "to select definite and important objects of science, which they may think most fit to be advanced by an application of the funds of the society, either in compensation for labour, or in defraying the expense of apparatus, or otherwise, stating their reasons for their selection, and, when they may think proper, designating individuals to undertake the desired investigations." The several proposals were submitted to the Committee of Recommendations, whose approval was necessary before they could be passed by the General Committee. The regulations then laid down still guide the association in the distribution of its grants. At that early meeting the association was enabled to apply £600 to these objects.

I have always wondered at the foresight of the framers of the constitution of the British Association, the most remarkable feature of which is the lightness of the tie which holds it together. It is not bound by any complex central organisation. It consists of a federation of sections, whose youth and energy are yearly renewed by a succession of presidents and vice-presidents, whilst in each section some continuity of action is secured by the less movable secretaries. The governing body is the General Committee, the members of which are selected for their scientific work; but their controlling power is tempered by the law that all changes of rules, or of constitution, should be submitted to and receive the approval of the Committee of Recommendations. This committee may be described as an ideal second chamber. It consists of the most experienced members of the association. The administration of the association in the interval between annual meetings is carried on by the council, an executive body, whose duty it is to complete the work of the annual meeting (*a*) by the publication of its proceedings; (*b*) by giving effect to resolutions passed by the General Committee; (*c*) it also appoints the Local Committee and organises the *personnel* of each section for the next meeting. I believe that one of the secrets of the long-continued success and vitality of the British Association lies in this purely democratic constitution, combined with the compulsory careful consideration which must be given to suggested organic changes.

The association is now in the sixty-fifth year of its existence. In its origin it invited the philosophical societies dispersed throughout Great Britain to unite in a co-operative union. Within recent years it has endeavoured to consolidate that union. At the present time almost all important local scientific societies scattered throughout the county, some 66 in number, are in correspondence with the association. Their delegates hold annual conferences at our meetings. The association has thus extended the sphere of its action: its places the members of the local societies engaged in scientific work in relation with each other, and brings them into co-operation with members of the association and with others engaged in original investigations, and the papers which the individual societies publish annually are catalogued in our report. Thus by degrees a national catalogue will be formed of the scientific work of these societies. The association has, moreover, shown that its scope is coterminous with the British empire by holding one of its annual meetings at Montreal, and we are likely soon to hold a meeting in Toronto.

Conditions of Certain Sciences at the Formation of the British Association.

The association at its first meeting began its work by initiating a series of reports upon the then condition of the several sciences. A rapid glance at some of these reports will not only show the enormous strides which have been made since 1831 in the investigation of facts to elucidate the laws of Nature, but it may afford a slight insight into the impediments offered to the progress of investigation by the mental condition of the community, which had been for so long satisfied to accept assumptions without undergoing the labour of testing their truth by ascertaining the real facts. This habit of mind may be illustrated by two instances selected from the early reports made to the association. The first is afforded by the report made in 1832, by Mr. Lubbock, on "Tides." This was a subject necessarily of importance to England as a dominant power at sea. But in England records of the tides had only recently been commenced at the dockyards of Woolwich, Sheerness, Portsmouth, and Plymouth, on the request of the Royal Society, and no information had been collected upon the tides on the coasts of Scotland and Ireland. The British Association may feel pride in the fact that within three years of its inception—viz., by 1834—it had induced the Corporation of Liverpool

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to establish two tide gauges, and the Government to undertake tidal observations at 500 stations on the coasts of Britain.

Another cognate instance is exemplified by a paper read at the second meeting, in 1832, upon the "State of Naval Architecture in Great Britain." The author contrasts the extreme perfection of the carpentry of the internal fittings of the vessels with the remarkable deficiency of mathematical theory in the adjustment of the external form of vessels, and suggests the benefit of the application of refined analysis to the various practical problems which ought to interest shipbuilders—problems of capacity, of displacement, of stowage, of velocity, of pitching and rolling, of masting, of the effects of sails and of the resistance of fluids; and, moreover, suggests that large-scale experiments should be made by Government, to afford the necessary data of calculation. Indeed, when we consider how completely the whole habit of mind of the populations of the Western world has been changed, since the beginning of the century, from willing acceptance of authority as a rule of life to a universal spirit of enquiry and experimental investigation, is it not probable that this rapid change has arisen from society having been stirred to its foundations by the causes and consequences of the French Revolution? One of the earliest practical results of this awakening in France was the conviction that the basis of scientific research lay in the accuracy of the standards by which observations could be compared; and the following principles were laid down as a basis for their measurements of length, weight, and capacity—viz., (1) that the unit of linear measure applied to matter in its three forms of extension—viz., length, breadth, and thickness—should be the standard of measures of length, surfaee, and solidity; (2) that the cubic contents of the linear measure in decimetres of pure water at the temperature of its greatest density should furnish at once the standard weight and the measure of capacity.* The metric system did not come into full operation in France till 1840, and it is now adopted by all countries on the continent of Europe except Russia.

The standards of length which were accessible in Great Britain at the formation of the association were the parliamentary standard yard lodged in the Houses of Parliament (which was destroyed in 1834 in the fire which burned the Houses of Parliament), the Royal Astronomical Society's standard, and the 10ft. bar of the Ordnance Survey. The first two were assumed to afford exact measurements at a given temperature. The Ordnance bar was formed of two bars on the principle of a compensating pendulum, and afforded measurements independent of temperature. Standard bars were also disseminated throughout the country, in possession of the corporations of various towns. The British Association early recognised the importance of uniformity in the record of scientific facts, as well as the necessity for an easy method of comparing standards and for verifying differences between instruments and apparatus required by various observers pursuing similar lines of investigation. At its meeting at Edinburgh in 1834 it caused a comparison to be made between the standard bar at Aberdeen, constructed by Troughton, and the standard of the Royal Astronomical Society, and reported that the scale "was exceedingly well finished; it was about 1-500th of an inch shorter than the 5ft. of the Royal Astronomical Society's scale, but it was evident that a great number of minute, yet important, circumstances have hitherto been neglected in the formation of such scales, without an attention to which they cannot be expected to accord with that degree of accuracy which the present state of science demands." Subsequently, at the meeting at Newcastle in 1863, the association appointed a committee to report on the best means of providing for a uniformity of weights and measures with reference to the interests of science. This committee recommended the metric decimal system—a recommendation which has been endorsed by a committee of the House of Commons in the last session of Parliament.

British instrument-makers had been long conspicuous for accuracy of workmanship. Indeed, in the eighteenth century practical astronomy had been mainly in the hands of British observers; for although the mathematicians of France and other countries on the continent of Europe were occupying the foremost place in mathematical investigation, means of astronomical observation had been furnished almost exclusively by English artisans. The sectors, quadrants, and circles of Ramsden, Bird, and Cary were inimitable by Continental workmen. But the accuracy of the mathematical-instrument maker had not penetrated into the engineer's workshop. And the foundation of the British Association was coincident with a rapid development of mechanical appliances. At that time a good workman had done well if the shaft he was turning, or the cylinder he was boring, "was right to the 1-32nd of an inch." This was, in fact, a degree of accuracy as fine as the eye could usually distinguish. Few mechanics had any distinct knowledge of the method to be pursued for obtaining accuracy; nor, indeed, had practical men sufficiently appreciated either the immense importance or the comparative facility of its acquisition. The accuracy of workmanship essential to this development of mechanical progress required very precise measurements of length, to which reference could be easily made. No such standards were then available for the workshops. But a little before 1830 a young workman named Joseph Whitworth realised that the basis of accuracy in machinery was the making of a true plane. The idea occurred to him that this could only be secured by making three independent plane surfaces; if each of these would lift the other, they must be planes, and they must be true. The true plane rendered possible a degree of accuracy beyond the wildest dreams of his contemporaries in the construction of the lathe and the planing machine, which are used in the manufacture of all tools. His next step was to introduce an exact system of measurement, generally applicable in the workshop. Whitworth felt that the eye was altogether inadequate to secure this, and appealed to the sense of touch for affording a means of comparison. If two plugs be made to fit into a round hole, they may differ in size by a quantity imperceptible to the eye, or to any ordinary process of measurement, but in fitting them into the hole the difference between the larger and the smaller is felt immediately by the greater ease with which the smaller one fits. In this way a child can tell which is the larger of two cylinders differing in thickness by no more than 1-5000th of an inch. Standard gauges, consisting of hollow cylinders with plugs to fit, but differing in diameter by the 1-1000th or the 1-10000th of an inch were given to his workmen, with the result that a degree of accuracy inconceivable to the ordinary mind became the rule of the shop. To render the construction of accurate gauges possible Whitworth devised his measuring machine, in which the movement was effected by a screw; by this means the distance between two true planes might be measured to the one-millionth of an inch. These advances in precision of measurement have enabled the degree of accuracy, which was formerly limited to the mathematical-instrument maker, to become the common property of every machine shop. And not only is the latest form of steam-engine, in the accuracy of its workmanship, little behind the chronometer of the early part of the century, but the accuracy in the construction of experimental apparatus which has thus been introduced has rendered possible recent advances in many lines of research.

Lord Kelvin said in his presidential address at Edinburgh, "Nearly all the grandest discoveries of science have been but the rewards of accurate measurement and patient, long-continued labour in the sifting of numerical results." The discovery of argon, for which Lord Rayleigh and Prof. Ramsay have been awarded the Hodgkin prize by the Smithsonian Institution, affords a remarkable illustration of the truth of this remark. Indeed, the provision of accurate standards not only of length, but of weight, capacity, temperature, force, and energy are amongst the foundations of scientific investigation. In 1842 the British Association obtained the opportunity of extending its usefulness in this direction. In that year the Government gave up the Royal Observatory at Kew, and offered it to the Royal Society, who declined it. But the British Association accepted the charge. Their first object was to continue Sabine's valuable observations upon the vibrations of a pendulum in various gases, and to promote pendulum observations in various parts of the world. They subsequently extended it into an observatory for comparing and verifying the various instruments which recent discoveries in physical science had suggested for continuous meteorological and magnetic observations, for observations and experiments on atmospheric electricity, and for the study of solar physics. This new departure afforded a means for ascertaining the advantages and disadvantages of the several varieties of scientific instruments, as well as for standardising and testing instruments, not only for instrument-makers, but especially for observers by whom simultaneous observations were then being carried on in different parts of the world, and also for training observers proceeding abroad on scientific expeditions. Its special object was to promote original research, and expenditure was not to be incurred on apparatus merely intended to exhibit the necessary consequences of known laws.

The rapid strides in electrical science had attracted attention to the measurement of electrical resistances, and in 1859 the British Association appointed a special committee to devise a standard. The standard of resistance proposed by that committee became the generally accepted standard, until the requirements of that advancing science led to the adoption of an international standard. In 1866 the Meteorological Department of the Board of Trade entered into close relations with the Kew Observatory. And in 1871 Mr. Gassiot transferred £10,000 upon trust to the Royal Society for the maintenance of the Kew Observatory for the purpose of assisting in carrying on magnetical, meteorological, and other physical observations. The British Association thereupon, after having maintained this observatory for nearly 30 years at a total expenditure of about £12,000, handed the observatory over to the Royal Society.

The *Transactions* of the British Association are a catalogue

* The litre is the volume of a kilogramme of pure water at its maximum density, and is slightly less than the litre was intended to be—viz., one cubic decimetre. The weight of a cubic decimetre of pure water is 1 000013 kilogrammes.

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of its efforts in every branch of science, both to promote experimental research and to facilitate the application to the practical uses of life. But probably the marvellous development in science which has accompanied the life-history of the association will be best appreciated by a brief allusion to the condition of some of the branches of science in 1831 as compared with their present state.

Geological and Geographical Science.

Geology.—At the foundation of the association, geology was assuming a prominent position in science. The main features of English geology had been illustrated as far back as 1821, and, among the founders of the British Association, Murchison and Phillips, Buckland, Sedgwick and Conybeare, Lyell, and De la Beche, were occupied in investigating the data necessary for perfecting a geological chronology by the detailed observations of the various British deposits, and by their co-relation with the Continental strata. They were thus preparing the way for those large generalisations which have raised geology to the rank of an inductive science. In 1831 the Ordnance maps published for the southern counties had enabled the Government to recognise the importance of a geological survey by the appointment of Mr. De la Beche to affix geological colours to the maps of Devonshire and portions of Somerset, Dorset, and Cornwall; and in 1835 Lyell, Buckland, and Sedgwick induced the Government to establish the Geological Survey Department, not only for promoting geological science, but on account of its practical bearing on agriculture, mining, the making of roads, railways, and canals, and on other branches of national industry.

Geography.—The Ordnance survey appears to have had its origin in a proposal of the French Government to make a joint measurement of an arc of the meridian. This proposal fell through at the outbreak of the Revolution, but the measurement of the base for that object was taken as a foundation for a national survey. In 1831, however, the Ordnance Survey had only published the 1in. map for the southern portion of England, and the great triangulation of the kingdom was still incomplete. In 1834 the British Association urged upon the Government that the advancement of various branches of science was greatly retarded by the want of an accurate map of the whole of the British Isles, and that consequently the engineer and the meteorologist, the agriculturist and the geologist, were each fettered in their scientific investigations by the absence of those accurate data which now lie ready to his hand for the measurement of length, of surface, and of altitude. Yet the first decade of the British Association was coincident with a considerable development of geographical research. The association was persistent in pressing on the Government the scientific importance of sending the expedition of Ross to the Antarctic and of Franklin to the Arctic regions. We may trust that we are approaching a solution of the geography of the North Pole; but the Antarctic regions still present a field for the researches of the meteorologist, the geologist, the biologist, and the magnetic observer, which the recent voyage of M. Borchgrevink leads us to hope may not long remain unexplored. In the some decade the question of an alternative route to India by means of a communication between the Mediterranean and the Persian Gulf was also receiving attention, and in 1835 the Government employed Colonel Chesney to make a survey of the Euphrates valley in order to ascertain whether that river would enable a practicable route to be formed from Iskanderoon, or Tripoli, opposite Cyprus, to the Persian Gulf. His valuable surveys are not, however, on a sufficiently extensive scale to enable an opinion to be formed as whether a navigable waterway through Asia Minor is physically practicable, or whether the cost of establishing it might not be prohibitive. The advances of Russia in Central Asia have made it imperative to provide an easy, rapid, and alternative line of communication with our Eastern possessions, so as not to be dependent upon the Suez Canal in time of war. If a navigation cannot be established, a railway between the Mediterranean and the Persian Gulf has been shown by the recent investigations of Messrs. Hawkshaw and Hayter, following on those of others, to be perfectly practicable and easy of accomplishment; such an undertaking would not only be of strategical value, but it is believed it would be commercially remunerative. Speke and Grant brought before the association at its meeting at Newcastle, in 1863, their solution of the mystery of the Nile basin, which had puzzled geographers from the days of Herodotus, and the efforts of Livingstone and Stanley and others have opened out to us the interior of Africa. I cannot refrain here from expressing the deep regret which geologists and geographers, and indeed all who are interested in the progress of discovery, feel at the recent death of Joseph Thomson. His extensive, accurate, and trustworthy observations added much to our knowledge of Africa, and by his premature death we have lost one of its most competent explorers.

Chemical, Astronomical, and Physical Science.

Chemistry.—The report made to the association on the state of the chemical sciences in 1832 says that the efforts of investigators were then being directed to determining with accuracy the true nature of the substances which compose the various products of the organic and inorganic kingdoms, and the exact ratios by weight which the different constituents of these substances bear to each other. But since that day the science of chemistry has far extended its boundaries. The barrier has vanished which was supposed to separate the products of living organisms from the substances of which minerals consist, or which could be formed in the laboratory. The number of distinct carbon compounds obtainable from organisms has greatly increased, but it is small when compared with the number of such compounds which have been artificially formed. The methods of analysis have been perfected. The physical, and especially the optical, properties of the various forms of matter have been closely studied, and many fruitful generalisations have been made. The form in which these generalisations would now be stated may probably change, some, perhaps, by the overthrow or disuse of an ingenious guess at Nature's workings, but more by that change which is the ordinary growth of science—namely, inclusion in some simpler and more general view. In these advances the chemist has called the spectroscope to his aid. Indeed, the existence of the British Association has been practically coterminous with the comparatively newly developed science of spectrum analysis, for though Newton,* Wollaston, Fraunhofer, and Fox Talbot had worked at the subject long ago, it was not till Kirchhoff and Bunsen set a seal on the prior labours of Stokes, Angström, and Balfour Stewart that the spectra of terrestrial elements have been mapped out and grouped; that by its help new elements have been discovered, and that the idea has been suggested that the various orders of spectra of the same element are due to the existence of the element in different molecular form—allotropic or otherwise—at different temperatures. But great as have been the advances of terrestrial chemistry through its assistance, the most stupendous advance which we owe to the spectroscope lies in the celestial direction.

Astronomy.—In the earlier part of this century, whilst the sidereal universe was accessible to investigators, many problems outside the solar system seemed to be unapproachable. At the third meeting of the association, at Cambridge, in 1833, Dr. Whewell said that astronomy is not only the queen of science, but the only perfect science, which was "in so elevated a state of flourishing maturity that all that remained was to determine with the extreme of accuracy the consequences of its rules by the profoundest combinations of mathematics; the magnitude of its data by the minutest scrupulousness of observation." But in the previous year—viz., 1832—Airy, in his report to the association on the progress of astronomy, had pointed out that the observations of the planet Uranus could not be united in one elliptic orbit—a remark which turned the attention of Adams to the discovery of Neptune. In his report on the position of optical science in 1832, Brewster suggested that with the assistance of adequate instruments "it would be possible to study the action of the elements of material bodies upon rays of artificial light, and thereby to discover the analogies between their affinities and those which produce the fixed lines in the spectra of the stars; and thus to study the effects of the combustions which light up the suns of other systems." This idea has now been realised. All the stars which shine brightly enough to impress an image of the spectrum upon a photographic plate have been classified on a chemical basis. The close connection between stars and nebulæ has been demonstrated; and while, on the one hand, the modern science of thermodynamics has shown that the hypothesis of Kant and Laplace on stellar formation is no long tenable, enquiry has indicated that the true explanation of stellar evolution is to be found in the gradual condensation of meteoritic particles, thus justifying the suggestions put forward long ago by Lord Kelvin and Prof. Tait. We now know that the spectra of many of the terrestrial elements in the chromosphere of the sun differ from those familiar to us in our laboratories. We begin to glean the fact that the chromospheric spectra are similar to those indicated by the absorption going on in the hottest stars, and Lockyer has not hesitated to affirm that these facts would indicate that in those localities we are in the presence of the actions of temperatures sufficiently high to break up our chemical elements into finer forms. Other students of these phenomena may not agree in this view, and possibly the discrepancies may be due to default in our terrestrial chemistry. Still, I would recall to you that Dr. Carpenter, in his presidential address at Brighton in 1872, almost censured the speculations of Frankland and Lockyer in 1868 for attributing a certain bright line in the spectrum of solar prominences

* Joannes Marcus Marci, of Kronland, in Bohemia, was the only predecessor of Newton who had any knowledge of the formation of a spectrum by a prism. He not only observed that the coloured rays diverged as they left the prism, but that a coloured ray did not change in colour after transmission through a prism. His book, "Thaumantias. Liber de Arcu Cœlesti Deque Colorum Apparentium Natura," Prag, 1648, was, however, not known to Newton, and had no influence upon future discoveries.

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(which was not identifiable with that of any known terrestrial source of light) to a hypothetical new substance which they proposed to call "helium," because "it had not received that verification which, in the case of Crookes's search for thallium, was afforded by the actual discovery of the new metal." Ramsay has now shown that this gas is present in dense minerals on earth; but we have now also learned from Lockyer that it and other associated gases are not only found with hydrogen in the solar chromosphere, but that these gases with hydrogen form a large percentage of the atmospheric constituents of some of the hottest stars in the heavens. The spectroscope has also made us acquainted with the motions and even the velocities of those distant orbs which make up the sidereal universe. It has enabled us to determine that many stars, single to the eye, are really double, and many of the conditions of these strange systems have been revealed. The rate at which matter is moving in solar cyclones and winds is now familiar to us. And I may also add that quite recently this wonderful instrument has enabled Prof. Keeler to verify Clerk-Maxwell's theory that the rings of Saturn consist of a marvellous company of separate moons—as it were, a cohort of courtiers revolving round their queen—with velocities proportioned to their distances from the planet.

(To be continued.)

The following paper was read in Section G:

The Subject of Light Railways as an Assistance to Agriculture.

BY MAJOR-GENERAL WEBBER, C.B, R.E.

A new impetus was given to the extension of light railways in the United Kingdom, as my hearers are aware, by the President of the Board of Trade under the late Government, who last December summoned a meeting of representatives of various bodies and interests, and selected from its members a committee to consider the subject. One of the results was that the then Government included in the Queen's speech, read at the opening of the parliamentary session of 1895, a reference to the subject, as a possible amelioration of agricultural depression. From the first moment, even before the committee was formed, a considerable divergence of opinion as to the best way of promoting the objects of the conference was evident. I believe we are indebted for this revival of the subject of extension of light railways in this country to the electrical industry, which, following on the vast extension of electric traction in the United States, had for some time been engaged not only in demonstrating its possibilities, but also in showing that electric traction was being practically discouraged under the stringent Board of Trade rules, which had been originally framed in the interests of public safety for the control of railway construction and working, and which had only been filtered in the course of their application to tramways worked with steam and cable traction. There seems to be a natural tendency in the minds of a population, accustomed to seeing draught animals in front of all road vehicles, to apprehend some special danger from a vehicle which is propelled by some unusual means, travelling on, or by, a public road. Steam traction, on road tramways, as existing in crowded thoroughfares at Leeds and Birmingham, may, on the other hand, be cited to show how the public may become accustomed to the proximity of a steam locomotive, an object which railways have taught them to regard as best out of the way and running between two fences.

Besides such examples as those above referred to, a few cable traction lines, such as those at Edinburgh, and two or three electric lines, such as that in Staffordshire, had been established. The public here had but few examples of light lines not worked with horses, which are not practically railways in the sense that they are not fenced in. What are known as "light railways" in Ireland are not in the category of the subject with which I desire to deal. From the first they were destined, by the preponderance of railway opinion which was on the commission of enquiry into the subject, and which made the recommendation under which Parliament provided the guarantee of the cost of their construction, to be railways in the ordinary acceptation of the term. They are practically branch feeders of the Irish railway system, and are no doubt well adapted to the wants of the districts into which they have penetrated, but they do not afford much guidance to the working out of such a problem as we have met to consider. In the same category I include the line well known to you all—viz., from Halesworth to Southwold. This line was originally projected to be laid at the side of the Ipswich and Lowestoft turnpike road starting from Darsham, but when its design was radically changed it ceased to afford a practical example, either from the engineering or the commercial point of view, of the kind of transport to which I seek to direct your attention. At the same time Ireland was early in the field with its steam road tramways between Dublin and Lucan and between Cork and Blarney, both of which have been successful.

I do not wish to cast any invidious reflection on railway engineers and managers, when I ask you to realise that their training and lifework is likely to unfit them for dealing with our subject, and that those of them only who in considering it have cast themselves adrift from their traditions can impartially study the question. The material they have handled all their lives, the traffic they have managed, the capital expenditure with which they deal, and the rules and regulations under which they work, with the necessary organisation and administration involved, is as different as the highly-appointed four-horse mail coach was from the old packman's beast of burthen. It was therefore particularly unfortunate when, in selecting the committee to which I have already referred, the strongest men on it were taken from the representatives of the great railway companies, and these chiefly from the least practical side of that representation. I don't know whether I am right in suggesting that a strong motive for thus packing that jury had official inspiration from the point of view of finance. Some of the original promoters of the movement had not concealed a strong opinion that in their opinion Government guarantees are inseparable from the success of such a movement, at any rate at its start. There was no disguise that the public department which called the conference together, had not the least idea of making any admission in that direction. Hence the endeavour to enlist the interest of the railway companies, in the hope that they may see their way to finance schemes of the kind. But from the first this was fatal to the production of anything but a paper report.

When the chief financial support was looked for from the railway companies, and that condition became the preponderating one with the committee, the possibility of agriculture ever being extensively assisted by light railways became remote. So much was I impressed at the time with this that I addressed the following letter to the *Times*, which that journal was good enough to insert:

"LIGHT RAILWAYS.

"Sir,—A meeting such as that which yesterday I had the honour to attend leaves a deep impression on the mind as to its importance to the future of the population of this country when presided over and conducted as has been the case with the conference at the Board of Trade by Mr. Bryce, and attended by delegates from every affiliated interest.

"Unavoidably some aspects of the question received undue attention, and others were overlooked for want of time. One which especially interests agriculturists, as the shorthand writer's notes will show, has been altogether unnoticed. I refer to the conditions which must guide the construction and working of light railways if they are to be made available for providing useful transportation to or from the homestead, and to or from any part of the farmer's holding, at which his crop can be collected.

"In the sugar and cotton plantations abroad, for instance, portable railways, of the same gauge as the lines to which they form temporary feeders, are laid on to the cultivated lands, and are shifted when required.

"The weight of these rails and the trucks that can be used on them must be well within the physical power, for laying and working, of the men and horses on the farm. The well-known gauges and weights for such lines should govern the same conditions in the light railways for agricultural districts now under consideration, so that each cultivator being provided with the necessary equipment, costing £200 a mile (less than a wagon and team), can run the trucks from a siding to any convenient point of his land, whence his crop can be taken on rails right away to its destination, and to which can be brought all that it is necessary he should procure from a distance.

"It is certain that anything that does not permit of such provision will fail to afford the relief to agriculture which was the primary object of the conference.

"The conditions as tothe size of holdings, as to the *petite culture*, as to the share which women and children take in producing the larger portion of the small produce which finds its way to us from the Continent, are so different here to what they are in, say, France, Belgium, and Denmark, that the example of what the light railways do there for the agriculturist is not quite applicable here.

"It will therefore be inferred that the conclusion to which I would lead is—that the light rail, or tram, ways of 1½ft. to 2½ft. gauge, requiring a width of ground of 4½ft. to 6ft., and costing altogether under £1,500 a mile, is the character of line for which legislation and regulation should be most urgently sought.

"I am led to ask you to allow this view of the question admission to your columns, because I, with others, came away from the conference with the fear that it may be lost sight of, instead of being made almost paramount, if real assistance to agriculture is intended.—Your obedient servant,

"C. E. WEBBER."

The Portrush and Giant's Causeway Light Railway is, in contradistinction to the Irish light railways I have already mentioned, a light railway on a public highway. It has been 12 years running, and is one of several examples which show that Ireland has been far in advance of the sister isle in some important features of this kind of locomotion. The road is

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worked by electricity, the conductor being of iron with a T section, the flat side being turned up, supported on wooden cleft posts at a height above the ground of about 2ft. 6in. I do not refer to this part of the construction as a sample of electric traction—the objections to it are sufficiently numerous to prevent their being repeated, and any description of them being of service here; but as a line bordering the hedgerow on one side of a road, which is about 30ft. from fence to fence, it is a very remarkable instance of what can be done. The line, which is 3ft. gauge, almost throughout its length skirts the highway, without any intervening fence, and is carried in the street right into the town of Portrush up to the railway station. When I saw it the streets and highway to the Causeway were as crowded with tourist traffic, vehicular and pedestrian, as any part of Ipswich and its environs on a market day. Yet no one seemed to take any notice of the not infrequent trains, even when they passed along by the kerb of the street footways, or to regard them as a source of danger not as easily avoided as any other vehicular traffic. In the town, and for a mile outside, each train, sometimes containing 120 passengers, is drawn by a steam locomotive; beyond that the electric traction comes into action. The usual train consists of two or three cars, but in the tourist season the trains have five or six. For these extra loads the steam locomotive runs all the way to the Giant's Causeway to help the electricity.

The chief feature in which this line is an example, is that small steam locomotives with short trains for goods and passengers have been worked for years alongside a public highway of ordinary width into a country town and through its streets with very rare cases of accident, and less in proportion to what is inseparable to the ordinary traffic in country roads which lead into a country town. The line is practically in the footway, and pedestrians step aside when they see a car approaching. At one point there is a siding across the road into a large lime quarry, so that the lime-trucks are taken into Portrush, about three miles, and the empties returned at a very trifling cost. An interesting feature, but one which is not in any way essential to a more modern electric railway, is the way in which the conducting-bar I have already mentioned is discontinued at each gate into a field, the current being carried by means of a covered cable under the ground between the ends. This I mention only to show that frequent gates into roadside fields are in no way an impediment to the use of light railways alongside roads in country districts.

According to the published reports in the year 1894, the total number of train miles run was 31,130, of which 10,487 was at 1s. 6d. a mile, by steam, and 20,643 was at 3½d. a mile, by electricity; but I have some doubts as to the accuracy of this comparison. This is essentially a passenger line, the traffic showing a total number of passengers of 93,917, the goods carried being no more than 26 tons, exclusive of parcels. This line, except in the town, is single. It is 8½ miles in length, and has cost £45,312 to construct and equip. It has never paid any interest on the £20,500 of share capital originally subscribed. The profit on the working in 1894, without placing anything to reserve, barely pays 3 per cent. on the amount raised by loans.

The subject of investigation to the engineer is how far experience would prove whether £5,448 per mile was excessive or not. There are elements of waste which are obvious—namely: (1) That the water power which generates the electricity is deficient in volume during the period of greatest traffic. (2) That the system of conductor used is unnecessarily costly, because of the frequency of the points all along the line at which it has to be interrupted, and continuity obtained by a length of costly underground cable of large section. (3) That there are evident causes of loss of electrical energy in the bad insulation of the bare conductor and the frequency of joints. (4) The necessity of supplementing the electric traction with steam locomotives makes heavy trains obligatory, and the waste of mixing the two kinds of traction will be obvious when the irregularity of the load which each has to take is considered. (5) All the advantage which electric traction gives of being able to run light loads at frequent intervals is lost, as the line is not constructed to provide for such a service; and it may also be said that, as the heavy passenger traffic chiefly reaches Portrush by rail, it is an obligation to have long trains to clear it.

It is quite certain that 7½ miles of the permanent way, with the rolling-stock added, exclusive of the locomotives and electric motor gearing, could have been provided for £1,800 a mile, if the rails had not had to be of the grooved form; the remaining mile might have cost at the rate of £2,800 a mile, making the total cost £16,300. How the cost of the traction—*i.e.*, the electric plant and equipment—and the steam locomotives, lands, and buildings came to £29,000 more requires explanation which I am not in a position to give. The only excuse which I conceive can be offered is that the line was built so long ago as 1882. The names associated with its initiation are those of Lord Kelvin and Sir William Siemens. One feels that the association was of more philanthropic than practical value. I mention this in particular, as it is necessary to forestall objections to the success of light railways which might be offered on account of the financial failure of an undertaking connected with such names.

Continental Light Railways.—Although not strictly dealing with engineering questions, the reports which Government has received on the subject of light railways on the Continent are important in their bearing on the subject under consideration. On December 4, 1894, Lieut.-Colonel Addison, R.E., reported to the Board of Trade on the light railway system in Belgium. He states that the Société Nationale des Chemins de Fer Vicinaux had 58 lines, with a total mileage of 730, and that projects were under consideration involving about 900 more miles. About 615 miles have a gauge of one metre, the rest is above a metre.

The average cost of construction was	£2,688
The amount paid for land less than (per mile)	220
Total (per mile).....	£2,908

The company has 245 locomotives, 663 passenger carriages, and 1,574 wagons and vans; generally 18-ton locomotives, some nearly 30 tons; of the wagons 70 per cent. carry 10 tons, the remainder five tons, a few 20 tons. The working expenses, 71·31 per cent. The proportion of the receipts from passenger and goods was 72 to 28.

Lieut.-Colonel Addison reported on his inspection of a line intended primarily to serve an agricultural district, and I have pleasure in drawing attention to it in detail: "This line is about 12½ miles in length, and is mainly dependent upon its goods traffic, which produced last year about 60 per cent. of the gross receipts of the line. Like all the Vicinaux railways, it is constructed on the road, excepting where steep gradients, etc., make slight diversions desirable. Usually a line of way is formed at one side of the road, raised slightly by ballast, etc., and separated from the remainder of the road by kerbstones; it resembles a footpath alongside a county road. In this way the railway is not available for ordinary carriage traffic, nor is it used by pedestrians. Through villages and where roads have to be crossed the line is of the usual tramway type. The line is of one metre gauge, with steel rails weighing 21½ kilos (42lb. per yard). In the towns, I believe, they use a deeper rail, weighing about 60lb. per yard. The rails are of the 'Vignolles' type, secured by dog spikes to creosoted sleepers about 4ft. 8in. × 8in. × 4in. Points are worked in the country by a lever at the side of the line, and in towns by a key fitting a screw-head placed between the rails."

Colonel Addison adds: "I did not obtain details of the curves and gradients of the Andenne-Eghezée line, but, as examples of the Vicinaux system, I take three lines, amounting to 45 miles in length, where the sharpest curves are 30 metres, 35 metres, and 40 metres respectively—*i.e.*, about 1½ to 2 chains radius. On the same lines there are gradients of 1 in 20 and 1 in 25. Round the very sharp curves, gauge ties are used to prevent the rails from opening. Guard rails are only used in towns. The speed is limited by regulation to 30 kilometres (about 18 miles) in the country and six miles per hour in towns and through villages; the time allowed in the time-table for the journey from Andenne to Eghezée, 12½ miles, averages 1 hour 25min., but one train in the day each way only takes about 1 hour 5min. The engine of the Andenne line, 18 tons weight, had six wheels coupled, each of 3ft. diameter; all moving parts were cased, and it was driven from either end (the driver of course always being in front). It was, in fact, an ordinary tramway locomotive. The engine was only provided with a hand-screw brake. I notice in the police regulations issued from the office of the Minister of Agriculture, etc., that the brakes on the engine wheels should be sufficient, alone, to stop the train on the steepest gradients in a length of 30 metres (33 yards). The engine always carries two men, a driver and a stoker. The train in which I travelled was composed, at starting, of one goods wagon next to the engine, one passenger carriage, and one fourgon, or luggage van; subsequently we dropped the goods wagon, but picked up three more wagons. The mixed trains usually have one van—in front of the train in one direction, and in rear on return journey. The van carries any passenger luggage and goods of small bulk. When not employed elsewhere the guard rides in the van, and makes out his way-bills, etc. For the suburban passenger traffic there is usually no van, but the society has a certain number of vehicles forming a second-class compartment and a small van. Vans have a post office letter-box, in which letters can be posted at the various halting places. There were several sidings on the Andenne-Eghezée line at the side of the road, so that carts could draw up alongside the goods wagons either to load or unload them. The running line is then outside the siding, on land acquired for the purpose. Sidings on the level usually had two dead ends, roughly made with a bank of earth and a few timbers. The stoker acts as foreman shunter at the sidings. The train only picks up loaded wagons, and does not stop to load *en route*. There were no signals of any description in use on the line I examined. M. de Burlet informed me they were only used at specially dangerous points, such as level cross-

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ings over main lines of railway, where there are safety points, and a signal indicates to the driver when he is approaching these points. Before sunrise, after sunset, and during foggy weather, the locomotive carries two white lights in front, one on either side, and a green light is attached to the tail of the train. A room in an inn generally forms a waiting-room for passengers, and a place where parcels can be left, either until called for or to be picked up by the train. No tickets are, however, issued, or ordinary station business transacted. I believe it is not usual to make any payment to the proprietor of the inn, who gladly affords these slight facilities in return for the custom brought to the house. In addition to the stations as above, there are also fixed points (with a notice-board only) where the train stops if there is anyone to pick up or set down—such as at important cross-roads, etc. At Eghezée the Vicinal railway connects with the main railway system. There is, however, neither here nor elsewhere any physical junction of the metre gauge with the 4ft. 8½in. gauge of the main lines. Riders, drivers of carriages, carts, etc., are warned upon the approach of a train to keep at least 5ft. clear of the rails. If the rider or driver is not sure of his horse, he is enjoined to lead it until the train is passed. Before crossing the railway persons are instructed to ascertain that no train is near. The level crossings of roads, excepting in a few instances, are not watched or guarded in any way."

Last month reports on light railways from her Majesty's representatives abroad were presented to Parliament. These reports were actually made to the Foreign Office in 1894, and refer to Hungary, Belgium, France, Germany, Italy, and the Netherlands. Her Majesty's representatives were requested to deal with (1) the mileage, gauges, etc., of the lines; (2) questions as to the means of providing capital; (3) working of the goods traffic with reference to the advantage to and the stimulation of the agricultural industries; (4) as to the carriage of passengers.

By far the most carefully worked out report is that by Mr. Stovin Warburton, consul at La Rochelle, on the tramways of the Charente Inferieurs. It is well worth the consideration of any community which may be considering the subject, because it is very discouraging, at first sight, but to my mind its chief value lies in its suggestiveness of what should be avoided. The empiricism of French finance and French red-tape comes out in every line. While I have the greatest admiration for everything done by French engineers, their legislators, small and great, are the least practical men in Europe. For instance, if more than two-thirds of the length of one of these lines is along the side of a roadway it is called, and worked as, a tramway; and under the opposite conditions it is classed as a railway. Bureaucracy shines out in the classification of the sources of guarantees of capital. The results are that both from the contractor's and the guarantors' point of view these lines do not pay. To quote the Consul: "The question naturally arises as to the benefit derived from them by the districts into which they have been introduced, and on this subject, having consulted persons competent to form an opinion, I have found it to be generally unfavourable. . . . They run through an agricultural country principally, so that it is to persons engaged in this occupation we should expect the principal benefit to accrue; but I believe that they will be very little used by most of them. The line passes by hundreds of farms of moderate size (say, from 20 to 200 acres), mostly tillage, which necessitates the use of horses and carts, several of which are generally kept on each farm. The farmers have produce to sell, but it is generally sold at the different market towns for 10 or 12 miles round, and delivered at the buyer's house. The tramway only runs from one point to another, and if it passes through a certain number of market towns, it leaves a far greater number equally near to any particular farmer untouched, so that in their case it is of no use to him at all. But even when it runs to the exact place to which he wants to send a load, he has first to cart it from his farm to the tramway, then load it on the wagons, and at the end of the journey put it on another cart to get it to the house of the purchaser, if sold; while if not, it has to be sent home in the same way: so that there are very few farmers who do not prefer to load their stuff and send it direct to the place of sale than to go through all these operations; and the idea of running sidings from the lines up to the farms is entirely illusory in this country, for no one would think of doing it."

He answers the question which rises to everyone's mind—namely, how the financing of these lines was made so easy—by a description of French legislation on the question of assistance to public works—which ought to make us thankful that our form of government has a fairly strong, independent, and common-sense executive, which practically is the only means of keeping political jobbing of all such kinds in check. He writes, "It is simply because of the great facility in France which exists of obtaining public money for these and other undertakings which would never have been attempted if they had to be made with private capital and for commercial reasons."

In the United Kingdom, only in Ireland as yet have the public purse strings been relaxed in consequence of the importunity of its representatives in the House of Commons. Districts in Ireland in receipt of State aid for public work are called "being spoonfed." In France the efficiency of a representative is measured by the amount of public funds he can direct to the help of local undertakings. The effect on the local taxation (besides that of the State) in France is very insignificant, the rise between 1862 and 1890 being from 15s. to £3. 4s. per head of population. The gauge of these lines is one metre, and the locomotive weighs 15 tons, and there is no motive for the contractor to keep the capital cost below £2,735 per mile. I submit that for the class of traffic, this gauge, these weights, and the costs are all much too high, and that the cause of the failure described lies in the fact they are not adapted to the wants of agriculture; and here, I repeat, the instincts of the so-called purely railway engineer have been at fault. If any local authority wishes to see what can be done with an 18in.-gauge line, with locomotives and rolling-stock to match, they have only to visit Woolwich Arsenal or Guinness's Brewery in Dublin, and see the simplicity and safety of its working, surrounded by crowds of men and vehicles, irrespective of the nature and weights of the loads that pass over these lines, as compared with what would be usual in country districts.

One of the best popular descriptions of pioneer and portable railways was read in June, 1891, before the Society of Engineers by Mr. John Kerr, one of the managing directors of Messrs. Dick, Kerr, and Co., and published in the *Proceedings* of that body. I do not propose to take up your time by repeating the details of construction of these light lines, varying between 16in. and 24in. gauge, as they are probably well known to all my audience who are engineers; but I cannot refrain quoting one paragraph from the paper, as it is essentially practical: "A man with an equilibrium tipping wagon can take a cubic yard of earth on a portable railway a distance of 220 yards, discharge the same, and return in five minutes; whereas it would be good work for the same man to accomplish this task in one hour with a barrow. Taking a labourer's wage at 6d. per hour, the result is a cost of ½d. per cube yard with portable railways, against 6d. in the other. Assuming a week's work under both systems, the following results may be deduced—viz., if 10 wagons per day are used, 6,000 cubic yards can be carried at a cost of £12. 10s. on the portable railway, while the same tonnage by the more primitive method would cost £150. In this calculation the working day is taken at 10 hours. The capital outlay for the railway and 10 wagons would be £110; and if the work had to be executed in the same time with barrows, the outlay would be, say, £90 on account of 125 barrows, and further, if, as would happen in many cases, wheeling planks are required, the total capital expenditure on both systems would be practically the same."

Unfortunately, the illustration is not quite on all fours with work in harvest time, but it is instructive. Mr. Kerr emphasises the following points in favour of the portable portion of a line, such as might be connected with the siding of a permanent 24in.-gauge line laid alongside the highway, and which would be the property of the farmer, to be laid into the homestead or fields, and shifted from place to place as required: (1) extreme simplicity; (2) quick mounting and dismounting of the line; (3) perfect security for correct gauge when laying the line; (4) the accuracy and non-variability of the gauge; (5) the portability of rails and sleepers when detached; (6) that skilled labour for laying the line is not required; (7) the ease with which a turnout can be made by taking out a 15ft. section of the way and substituting a section of points and crossings, of which the varieties made, such as right-hand and left-hand, two-throw and three-throw points, are all simple and cheap.

As regards the rolling-stock, which within the farm would be operated by animal or manual power, Mr. Kerr pointed out the extraordinary proportion of paying, or live, load to dead load, in comparison with the proportion usual in the case of an ordinary railway wagon—in the former case being as 1 to 4, in the latter as 1 to 2. Of course the material and design of the body of the wagon is determined by the nature of the work. The safe load per wheel varies from a 10in. 16lb. wheel at 12cwt. to an 18in. 56lb. wheel at 40cwt. For heavy materials, such as stones, earth, etc., cheaply-constructed wagons to hold 10 to 27 cubic feet, and costing from £6 to £8 each, are also available. If the lengths of light material are not more than 4ft. or 5ft. bogies are not wanted, but that form might be very useful generally for farm work. A useful wagon for agricultural transport on a 24in.-gauge line would be 16ft. long by 5ft. wide. It weighs 72cwt., and costs £30 (*vide* illustration).

Mr. Kerr described what he called a "pioneer railway," which, so far as price is concerned, meets the case we have under consideration, particularly if we assume that if a local organisation takes up the question in respect to one agricultural area (say, the county of Suffolk) they might consider it in view of a maximum of, say, 200 miles within the county. Let us assume that there would be 20 lines, each of an average length of 10 miles, and that they would be worked with steam locomotive. The cost would be as follows: The railway should be 24in. gauge, and laid with steel rails, 20lb. per yard, having 2,112

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steel sleepers (4ft. 6in. long over all) per mile—*i.e.*, sleepers laid 2ft. 6in. apart centre to centre. The illustrations will clearly illustrate the nature of the permanent way, and it will be seen that the sleepers have closed ends to prevent the ballast shifting. As regards the cost per mile for such a railway, at the present time, when prices are fairly normal, the total for iron-work, including rails, fishplates, bolts and nuts, sleepers and fastenings, would be £450.

200 miles of permanent way (24in. gauge), at £450	£90,000
200 miles of construction, at £450	90,000
Carriage and distribution of materials, say 11,000 tons, at £1	11,000
	191,000
7½ per cent. for engineering and sundries	14,325
	£205,325

or £1,027 per mile.

The expenditure on 20 lines would be:

40 stations and 20 workshops	£13,680
400 sets, points, and crossings	6,000
400 open goods wagons, at £25	10 000
100 covered goods wagons, at £50	5,000
40 timber wagons, at £25	1,000
40 brake vans, at £60	2,400
40 composite carriages, at £250	10,000
40 locomotives, at £700	28,000
	76,080
Add 7½ per cent. engineering, carriage, and contingencies	5,700
	£81,780

or £409 per mile. Total £287,105, or £1,436 per mile.

The above figure does not include anything for the purchase of lands, to which I shall refer further on.

In an investigation of the carrying capacity of these lines, it is assumed that the worst gradient would be 1 in 30, and that a train of, say, eight wagons, besides one brake van and one composite carriage, can be worked with a paying freight of 20 tons. If 20 such mixed trains run 40 miles a day each, we have a goods capacity of 800 train miles and 16,000 ton miles a day, or 4,944,000 ton miles a year. Taking one day with another, and considering the varying nature of the goods traffic, it may be estimated that the loads will amount to at least one-fourth the capacity, or 61,800 tons per annum on each of the 20 lines. This can bear an average rate of twopence (2d.) a ton per mile, and each line will receive for goods £515 per annum, or £10,300 on the whole. For the passenger traffic it may be estimated that on each line the carrying capacity will be per composite car:

	First class. 6 persons.	Third class. 24 persons.
Passenger miles per annum will be	98,800	296,640
The actual load estimated at one-fourth for first class at 1d. per mile, one-half for third class at ½d. per mile, will yield per annum	£77	£309

Total receipts passenger traffic, £386; or on the whole, £8,214. Goods and passengers together £18,514, which is almost exactly 1s. 6d. for each 247,200 mixed passenger and goods train mile.

Now as to expenditure: including all outgoings, I at once take my stand on 1s. a train mile. If the time would permit, I could describe economies in this figure, especially in the direction of oil-engine locomotives, or with boilers fixed with oil—both systems are practical. The Cork and Muskerry Light Railway Company in their report of February, 1895, on a length of 18 miles ran 83,872 train miles in 12 months, with a total outgoing of £3,938, or 11¼ per mile. The example least favourable to 1s. that I can find is that of the Clogher Valley Railway Company, in which the same figure is 15d. Now, these lines are constructed with a 5ft. 6in. gauge and worked as railways, and are burthened with all the expenses contingent on that system. The lines we are considering are essentially something much less costly in the working and construction: 1s. is therefore an outside figure. Of the above total of £18,514, there is therefore £6,540 left towards net revenue. To this may fairly be added as follows for each line:

Carriage of parcels and special objects	£30
Mails	15
Special excursion receipts (four days a year)	42
Advertising	12
Total	£99
Or on 20 lines	£1,980
Which, less 10 per cent. for expenses, gives an additional net revenue of	£1,782
Total net revenue	£8,322

This is at the rate of £2. 18s. per cent. on the capital. The above figures are compiled on each train, making but two return journeys on 309 days with goods and passengers, and eight return journeys with passengers on four days in the year. The extra net revenue, if traffic justifies an increase of trains in the day would (less a percentage) be to the good, and would increase the net profits. I have not included anything for the cost of intermediate stopping places, because on similar lines the total outlay is the cost of a notice board.

I now come to the all-important question of the purchase of lands, which some of my hearers may have thought I had overlooked. I have intentionally excluded it from the capital account, because I propose that it should be dealt with in the following way. The local authority—*i.e.*, the county council—will, no doubt, have full powers conferred upon them by Parliament to deal with this part of the question, and upon their manner of dealing with it, and upon the degree of their co-operation with and support of such a scheme, must depend the expenditure on the item of land. With the gauge proposed, and under the conditions described, I venture to predict that, including stations, the necessity for paying £50 a mile for land, including all the expenses of the local public enquiry—*i.e.*, £10,000 altogether—will be the outside figure, which at the present rate of borrowing powers and with sinking fund would come to £450 per annum. This is one burthen I propose the local authority should undertake as a fair expenditure to encourage local industry. The other is that they provide an annual amount to create a sinking fund at 1½ per cent. on the capital—viz., £4,305 per annum, total £4,755 per annum, or ·59 of 1d. in the £, to be added to present average poor-rate, which is about 1s. 6½d. In return for this support the local authority to have a claim on all net profits after 3 per cent. has been paid to the ordinary shares (say, two-thirds of the amount left over), also a representation on the direction, and the system to pass into their hands without further payment at the end of 42 years. We have been promised by two Governments that this matter shall at least have friendly assistance from the public revenue. In Ireland the baronies and the Imperial exchequer are burthened with much heavier charges per mile than those I suggest for Suffolk. The Treasury has already powers to help local rating for useful purposes. Can it apply them better than by taking half the above annual burden for Suffolk during 42 years? If the two-third deferred profits is also shared with the Treasury, and if an average for similar purposes of £2,377 per annum was granted to the 120 county councils in the United Kingdom it would only amount to £285,240 for 140 for 42 years. Everything points to an increase of traffic above that which I have estimated, and it may eventually prove the case that a loss in one area may be repaid the Treasury by a gain in another. In any case, it would be entirely optional with each local authority to deal or not with the initiators; and the Government share of the burthen need be undertaken only if the Local Government Board are assured of the prudence of the local authority in committing themselves to it.

Ipswich.

So as to bring the subject more home to the town in which we meet, I have prepared a map showing 11 or 12 possible light road lines radiating therefrom, designed to be constructed at the side of the public roads in the country and in the roadways where they pass through the streets; their routes and lengths are as follows:

Ipswich—Light Railways.

No.	Road route.	Mileage. Rural.	Urban.	Total.
1.	Nacton and Levington	3½	1¼	4¾
2.	Brightwell, Newbourne, and Hemley	6½	1½	8
3.	Kesgrave, Martlesham, and Woodbridge	5¾	3	8¾
4.	Tuddenham, Grundisburgh	5	1	6
5.	Westerfield, Witnesham, and Helmingham	7¼	¾	8
6.	Henley and Hemingstone	4¾	1	5¾
7.	Whitton and Claydon	2½	1	3½
8.	Bramford, Lt. Blakenham, and Offton	6¼	1	7¼
9.	Hintlesham and Hadleigh	8¼	1	9¼
10.	Copdock and Stratton St. Mary	9	½	9½
11.	Freston and Harkstead	5	1½	6½
		63¾	13½	77¼

Employing the figures in the former calculations, except, that £1,000 per mile is added for the cost of each mile for the cost of the urban lengths, the capital expenditure on the 77 miles, without the cost of land, will be £124,000. If 1s. 6d. a train mile can be earned with four return journeys on each of the 11 lines, and if the outgoings come to 1s., and if 6d. a train mile is profit, then these lines will pay 3 per cent. on the capital outlay. The guarantee charges which the localities would have to undertake are: first, the interest and sinking fund on 77 × £50 for land = £3,850, which is £173 per annum; second, the sinking fund on the capital outlay so as to secure quiet possession at the end of, say, 42 years—viz., 1½ per cent. on £124,000, 1,860; total guarantee for 42 years, per annum, £2,033. With the certainty of this annual charge being

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steadily reduced, as already described, as time and increase of population and business produced their natural effect. If the Government join in the guarantee as suggested, the burthen would be only £1,017 per annum. From the point of view of construction, the following is a description of the various routes inside Ipswich, which present no engineering difficulties for a 24in.-gauge line.

General Description of the Routes Inside the Municipal Boundary.

No. 1.—To LEVINGTON—A 30ft. to 35ft. road to Derby-road railway station to junction with No. 2 from Henley. The railway bridge is 30ft. wide, with an easy gradient of 1 in 35 or 40. Cannot obtain access to the town by Nacton-road, Bishop's-hill, and Port-road, owing to the narrowness of some of the roads, which are only 22ft. wide, and the gradient at Bishop's-hill is heavy, being 1 in 20.

No. 2.—To HENLEY—The road is 30ft. wide to its junction with No. 1 near Derby-road Station. From this point 30ft. to 35ft. wide, following the tramway along Caldwell-road and St. John's-road to its junction with No. 3 at Spring-road. Gradients easy.

No. 3.—To WOODBRIDGE—The road is 30ft. to 35ft. along Spring-road to its junction with No. 2. From Crabbe-street to junction with No. 2 the gradient is about 1 in 25; from this point the joint lines Nos. 1, 2, and 3 will follow the tramway route along Spring-road (passing under the railway with a 30ft. road), St. Helen's-street, Carr-street, and Tavern-street to Cornhill. This is a good wide road, 40ft. wide in many places, and never less than 30ft., and has a double line of tram rails from the Shire Hall to Cornhill. The gradients are easy. Cornhill (opposite the Town Hall and post office) makes a good central junction or station, being a fine open space at the head of Prince's-street, which is the main road from the centre of the town to the station, and along which the tramway runs. This road (Prince's-street), which averages 40ft. in width, and is in no case less than 30ft., would take the traffic from routes 1 to 6 to Commercial-street, which is 40ft. wide, facing the goods yard of the Great Eastern Railway. Commercial-street, having little or no traffic, except for merchandise from goods yard, would form a good terminal depôt for goods, owing to its proximity to the railway depot. There is no access to this point for the above routes, Nos. 1 to 6, further east than Prince's-street, the streets eastward being narrow and crowded, a considerable portion of all of them being only 22ft., and many of them only 20ft. wide, so that the routes cannot in this case be varied from that shown on plan, past the Shire Hall to Cornhill and along Prince's-street.

No. 4.—To GRUNDISBURGH—The road is 30ft. to 35ft. wide until it reaches the N.E. corner of St. Margaret's Churchyard, where the width for a few feet is reduced to 24ft., owing to the corner of the churchyard projecting; but the road is being widened, and it is understood this corner will be cut away. Another narrow portion is about 30ft. in length at the north end of Northgate-street. This short length is only 25½ft. wide, and is caused by one very old building used as a second-hand furniture shop. The remainder of Northgate-street to its junction with Nos. 1, 2, and 3 in Tavern-street is 35ft. wide. The gradient is a little heavy from Hervey-street to St. Margaret's Church, about 1 in 30. The remainder is easy.

No. 5.—To HELMINGHAM—A good road, about 35ft. wide to its junction with No. 4 at Tuddenham-road. The gradient for a very short length to the junction with No. 4 is about 1 in 30. The other gradients are easy.

No. 6.—To HEMINGSTONE—Over 30ft. wide. This will be taken as shown on plan, along the new road, 35ft. wide, bounding the northern side of Christchurch-park to its junction with No. 5 of the Westerfield-road, the most direct route along the Henley and Fonnereau roads having a long heavy gradient of 1 in 18 or 20.

No. 7.—To CLAYDON—A good wide road, with a easy gradient, and having a tram line along it for a considerable distance. From the barrack corner to the top of London-road it may be taken either along St. Matthew's and Westgate streets to Cornhill, which is 30ft. to 32ft. wide, and almost level, or along Portman's-road and Mill-street to Prince's-street. The latter route is about 40ft. wide, easy gradient, and not much traffic on it. There is a tram line laid, but its use has been discontinued.

No. 8.—To OFFTON—30ft. wide along Bramford-road until it reaches Bulwer-road, where it narrows to 22½ft., with a gradient of about 1 in 20 to its junction with Norwich-road. By turning the route, as shown on plan, along Bulwer-road to join route No. 9 in London-road, the gradient is easy, and width not less than 30ft.

No. 9.—To HADLEIGH—The road has a width of 30ft., but the bridges across the railway are only 25ft. wide, and the bridge across the backwater of the Gipping or Orwell is only 18½ft., that across the canal, called the Handford Bridge, is 35ft., and the width of road from here to barrack corner is 30ft. to 35ft. Gradients easy.

No. 10.—To STRATFORD ST. MARY—30ft. wide to its junction with No. 9 at Crane Hill Villas. Gradient easy.

No. 11.—To HARKSTEAD—30ft. and 35ft. wide to Stoke Bridge, which is only 22ft. wide. It is of iron, and would admit of a footway being attached, which would increase the width to 30ft. From the bridge to Commercial-street is about 40ft. wide. Gradients easy.

The routes all end in leading up to the main-line railway station of the South-Eastern Railway Company.

My audience may expect me to deal with this illustration of Ipswich from the point of view of the cost of electric traction. There is no difficulty whatever in working the 77 miles suggested by such means if overhead conductors are permitted. The refusal to allow them is ludicrous in view of what is carried out in towns like Lubeck, Gera, Essen, Markberg, Chemnitz, Halle, Kiew, Breslau, Christiania, and 20 other towns abroad. All these lines could be worked from one central electrical generating station. But they could not be made to pay with the sparse traffic and low rates with which I have been dealing. For instance, the cost of the construction of the overhead and return conductors would be £29,000. The cost of the central generating station, without the price of the site, would be about £17,000; allowing for one loaded train to be running at one time on each of the 11 lines. Against these figures, together amounting to a total of £46,000, we should only save about £5,000 in the locomotives. There will be the saving in coal, but the labour would be about the same. With denser traffic electric traction has its own place, just as with very dense traffic there is nothing that can touch cable traction for economy.

Now, as to this question of gauge upon which the future of the subject in my opinion may turn. I see that at Tiptree, in Essex, a light railway is projected, and that 4ft. 8½in. is proposed. I hope someone is here to state the arguments in its favour. They cannot deny that if they are going to take the produce straight out of the fields and homesteads, say, to London, there must be a change of gauge somewhere *en route*. The difference between us, where it is to be? I say it is best at the railway station on the main line, where appliances for shifting goods are available. Does the engineer of the proposed Tiptree line really expect the main-line rolling stock to be taken along his light railway? Admit he does. Does he propose to continue his 4ft. 8½in. gauge into the fields and up to the homestead, and if he does, and locomotives are not available, with what means of traction will he move the wagons full of produce or manure? And who will pay for the construction of these branch lines? If he cannot answer us, where is the advantage to agriculture of the line? It is being continually asserted that a 2ft. gauge is nearly as costly as a 4ft. 8in. I maintain that those who make this assertion are unconsciously influenced by the question of profits. Otherwise, why are 600 miles of line in Bolivia, hundreds of miles in India and Burmah, the Beira railway in South Africa, and numerous lines for plantation work all over our Colonies, all of narrow gauge varying between 20in. and 36in., and that in countries where the standard of the main lines is, as with us, much wider? But to show that under certain conditions this difficulty of transfer of load at a change of gauge may be met, I have the pleasure to exhibit (it is almost the first time it has been publicly shown) a very neat model made for me by the Lancaster Railway Carriage and Wagon Company some nine years ago. It shows how the loaded rolling-stock of a 4ft. 8½in. gauge railway can be transported on a transfer trolley along a light railway of 2ft. 6in. gauge. I may say at once that while it saves the transfer of the load, it involves a cost in rolling-stock and weight of rails which does not meet our case.

As population increases over the face of this country—and no one knows what it may reach in the next 40 years—unless we look well ahead there will be fearful retribution. London is, I fear, hopeless: we shirk contemplating the engineering bankruptcy of London 40 years hence. But many of our provincial cities and towns, especially in the rural districts, have their chances still. If they now realise what is coming they will extend their jurisdiction over the widest suburban areas possible, not following, but in advance of the population; not so as merely to provide the workers with houses in rows, but also with gardens and paddocks. Easy, cheap, and fairly rapid, set-down-and-pick-up means of carriage in every direction will alone make this possible. The owners of land, if they are wise, will encourage this in every way, as it will restore values, which many of them have thought were rapidly disappearing.

I cannot occupy more of your time except by challenging proof that there is anything practical or magical in the use of the 4ft. 8½in. gauge for our light railways. The volumes that have been written on the battle of the gauge did their work, whether for good or ill. It is now time to reopen the whole question.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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Vol. XV. of new series of "The Electrical Engineer" can had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers or binding can be obtained, price 2s.

ELECTRICITY IN MEDICINE.

From the earliest times the use of electricity as a curative agent in nervous and other diseases has been often described. Its application, however, has been largely left in the hands of electrical specialists whose knowledge of the human anatomy has unfortunately been exceedingly small. These gentlemen have numbered with them a certain proportion of quacks, who have conjured with the word "electricity," and by ribald advertisement have succeeded in deceiving a large number of people. The frauds thus fostered under the all-powerful name have brought a certain amount of discredit on this branch of the medical profession. There is also a deplorable want of knowledge of the subject amongst many medical practitioners. We are exceedingly glad, therefore, to see an article in a recent issue of the *Lancet* advocating the introduction of this branch of their profession in the education of medical students. We agree with this article in almost all respects, especially in the fact that electricity has been used in the past more as a stalking horse for rampant quackery, and in consequence of this has fallen into disfavour with a large section of the medical profession. The earliest cases on record in which good has been obtained from the use of electricity are perhaps more wonderful than true. In those days the apparatus at the command of the operators was of poor quality, and no means of measurement could be used. Since the year 1850 the subject has gradually occupied more attention, both from eminent specialists in England and on the Continent, and with the improved apparatus at their disposal exact information has been obtained to guide operators in the electrical treatment of the various diseases to which it is applicable. Although much has been written on the subject, we still think that there is room for a good and concise treatise on the advantages in various cases of using either alternating or direct currents.

Again, modern appliances are gradually being introduced which enable the operator to measure as well as regulate the amount of current applied. Instead of the old practice of regulating the quantity to just as much as the patient could bear, a definite prescription can now be administered which has been proved sufficient by previous experience. We cannot do better than to quote from the article referred to, which says, in support of the contention that more attention should be given to this subject in the various medical colleges, that "the range of utility of localised electrification is extending, and one very important point is becoming clear from the systematic work done in the electrical departments of the hospitals—namely, that patent electrical applications extending over long periods of time are able to do many things which might be thought unlikely or impossible by those who judge of electricity only by its immediate effects. There is not much which is instantaneous and there is nothing which is magical about the results of electrical treatment, and those who wish to benefit their patients by electricity must be willing to devote much time and patience to the treatment."

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THE BRITISH ASSOCIATION AT IPSWICH.

It is seldom that the presidents of the British Association have so intimate a knowledge of its great work as the gentleman who is presiding over the present meeting at Ipswich. Sir Douglas Galton has for some forty-six years attended the annual meetings, and during the last twenty-five years has most ably filled the post of general secretary; so it is with no small amount of personal feeling that he reviews the scientific progress made during that period and the means by which the association has fostered this progress. There is no doubt that the meeting of so many distinguished scientists to discuss the latest developments in their respective departments is one of the surest ways of spreading knowledge, and Sir Douglas Galton may justly feel proud of the service he has rendered in this cause. We trust that the present meeting may uphold throughout the promise of the programme. The papers of interest to our readers are quite as numerous as usual, and we shall welcome some, especially as they are by new writers on the subjects treated. Thus Mr. Preece will enlarge on his subject of inductive telegraphy, but will add another paper on incandescent lamps, which is likely to open up new ground. Major-General Webber is a new writer both on light railways and on telephones, and we expect new ideas from him. On the whole, although the attendance is below the average, we fancy that the working element is strongly represented, and that the Ipswich meeting of 1895 adds much to our general knowledge.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LIGHT RAILWAYS.

SIR,—In the *Times* on the 28th ult. there was an interesting account of a proposed light railway in the Peak district—interesting because the use of the side of an existing road is, no doubt, the proper method, and is in accord with the best examples of Continental experience. It is to be regretted, however, that a scheme of so much promise should have been presented to the landowners and others interested by those responsible in such a crude and imperfect manner.

In the first case it is called a light railway, which is incorrect, a nomenclature apparently of small consequence to the uninitiated, but of vital importance to those who are investors, if they are desirous of a dividend, though of small consequence to the promoters if their primary object is plunder. I am tempted to ask under what Act the promoters hope to obtain their powers to run 15 miles an hour on the public highway? It is true that the recommendations of the Light Railway Committee last year suggested an increase of speed, but at the present moment this is not to be obtained. It is also well known that the present conditions which apply to the working of light railways are more or less fatal to success.

As regards the cost of construction, it is unnecessary to say much beyond suggesting that £1,000 per mile appears a very low estimate, and is not borne out by Irish or Continental experience, and it may probably be found necessary to increase this.

It is stated that this line is proposed to be worked electrically—the announcement is interesting. To suggest that it ever will be is to accept Carlyle's definition of the inhabitants of the world, and apply it *without* the reservation to some of the votaries of electric traction.

To the technical men, who chiefly represent your readers, the reason is obvious; and if any further argument was necessary, the statistics given of the probable traffic and the service required for such traffic is convincing. The present price of electric traction is given at a fraction over 4d. per car mile; this is approximately the figure given as the cost of electric traction on the South Staffordshire tramways, the equipment and working of which is erroneously attributed to Messrs. Dickinson and Co., Birmingham.

It is misleading in the extreme to suggest, as is suggested, that the cost is the same for working 100,000 car miles on a light railway in Derbyshire, as is stated to be the cost on the South Staffordshire system, which is half the length, and runs 300,000 car miles per annum.

Taking the construction figure of the promoters at £1,000 per mile, the total cost, including a steam equipment and buildings, could not possibly cost more than £25,000; the total cost of working would, according to light railway experience in Ireland and the Continent, be about £3,500 per annum. If the promoters had such faith in the economy of electric traction that they believed they could work this proposed line at a total cost of 6d. per car mile, any economy made in this direction would be seriously handicapped by the interest on the difference of capital cost, given as £62,000.

It must not be assumed that I am in the slightest degree discounting the great value of electricity as an economical form of traction—on the contrary, I am a great believer in it—neither am I desirous of saying anything that would prejudice the introduction of light railways, but I do emphatically protest against the introduction of the mystic word "electricity" as a bait to the investor to subscribe to an over-capitalised line.

Tramways to this date suffer severely from over-capitalisation, mostly due to the introduction of the word "steam" and a promised reduction in working expenses. It is my object to prevent the over-capitalisation of light railways and subsequent failure due to the introduction of the word "electricity" and a suggested economy in working by its adoption.

It would thus appear to be good advice to the landowners, farmers, and others in the Peak district if they waited before investing any money in this scheme to the probably early alteration in the Legislature affecting light railways, as well as obtaining a little more experience before embarking in the use of electricity as a means of traction for rural lines.—Yours, etc., DIVIDEND.

FIRE.

SIR,—Mention having been made in the daily papers of the fire which occurred at our works last week, we beg to notify that our business is being carried on as usual, and that orders entrusted to our care can receive prompt attention. Through the prompt action of the fire brigade, the damage was restricted to one of the buildings in our works.—Yours, etc., GRIFFITHS BROS. AND CO.

Aquol Works, Bermondsey, S.E., September 11, 1895.

CITY AND GUILDS EXAMINATIONS, 1895.

ELECTRIC LIGHTING AND POWER DISTRIBUTION.

The following is the set of eight answers sent in by Mr. E. Basil Wedmore, of the electric lighting station, Temple Backs, Bristol:

2. What is the use of the series coil in arc lamps run in series with an unvarying current?

Answer.—The series coil is used to strike the arc—*i.e.*, to separate the carbons when the current commences to flow—the mechanism being balanced so that the carbons are drawn together by the weight of the moving parts when the current is not flowing.

6. How does slipping a copper tube over the core lessen the spark of an induction coil?

Answer.—The spark of an induction coil is due to the self-induction in the primary circuit. The effect of the

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copper tube is to lessen the self-induction and therefore the spark. The action is similar to that which takes place in a transformer with closed secondary circuit. Currents are induced in the copper which, by Lenz's law, are in such a direction as to oppose the alteration of the magnetic field by which they are being produced, therefore the total variation of the magnetic induction is lessened, and consequently the self-induction of the primary circuit and the spark.

Note.—It is the rate of change of induction which is most affected by the eddy currents. The E.M.F., being a function of the rate of change, is kept low, and hence the sparking is reduced.

12. A series dynamo has an armature resistance of 0·4 ohm and a field resistance of 0·6, and gives 120 terminal volts at a given speed and current of 10 amperes: work out its electrical efficiency as a dynamo and as motor at that speed and current.

Answer.—As dynamo: At 10 amperes the drop of potential in armature and field coils = C R = 10 (·6 + ·4) = 10 volts.

∴ Total volts produced in armature = 120 + 10 = 130 V;
∴ total watts produced by armature = 1,300.

But watts given out at terminals = 1,200,

$$\therefore \text{Efficiency} = \frac{12}{13} = 92{\cdot}3 \text{ per cent.}$$

As motor: The back E.M.F. of armature at given speed is (as seen above) 130 volts. The drop of potential in armature and field coils at 10 amperes = 10 volts; ∴ to send 10 amperes through machine 140 volts will have to be supplied to terminals—*i.e.*, 1,400 watts supplied, 1,300 watts converted into useful work.

$$\therefore \text{Efficiency} = \frac{13}{14} = 92\ 9 \text{ per cent.}$$

Note.—This was the only correct answer received to this question.

13. Describe one kind of alternate-current motor.

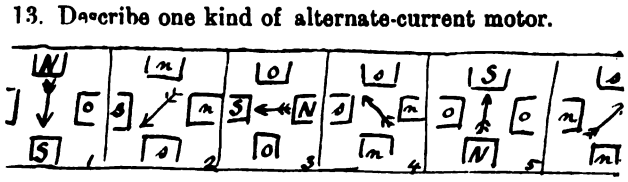

FIG. 1.

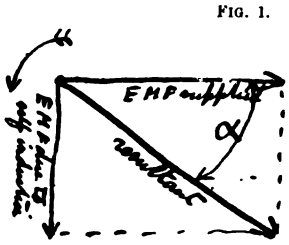

FIG. 2.

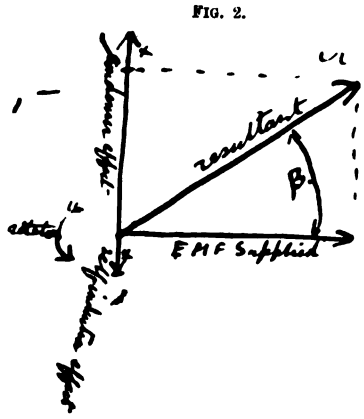

FIG. 3.

Answer.—The simplest form of alternate-current motor is one with a rotary field. In this motor the armature consists of an iron ring, disc, or drum, mounted to revolve on its axis, and usually wound with a copper wire forming one or more closed circuits. The action of the rotating field on such an armature is to produce polarity in the iron, both by direct induction and by means of currents induced in the copper circuits. It will be seen by inspection that the poles thus produced will lag behind the polarity of the rotating field, and consequently the ring will tend to follow the rotating field. It is obvious that the ring can never rotate as fast as the field, as in that case there would be no lag, and therefore no torque. The ring therefore rotates at a slower speed than the field. If the load on the armature is altered—say, increased—the speed of the ring will alter until the increased torque (due to the currents in the coils being increased by the increased cutting of lines of force due to the increased difference of speed) and the reduced speed overcome the load applied. The rotating field is produced from a two-phase current obtained either from a two-phase supply or by the conversion of a single-phase current into a two-phase one, as in the Ferrari and Brown motors. The conversion is effected by dividing the magnets into two circuits, every alternate magnet being on the same circuit, and making the phase of the current in one circuit lag behind the supply by means of large self-induction, and, as in the Brown motor, by making the phase keep ahead of the supply in the other circuit by means of a condenser. Assume the phase to differ in the two circuits by 90deg., and the diagrams (Figs. 1, 2, and 3) for a four-pole machine will prove that the resultant field rotates. The conditions necessary to obtain a difference of phase of 90deg. are represented thus:

$$\text{First circuit, } \alpha + \beta \text{ must } = 90\text{deg.},$$

which shows that efficiency of motor must vary largely with load.

Note.—The general tone of the answer shows that Mr. Wedmore understands the principles of construction of rotary-field motors, but in single-phase motors he confuses the starting arrangements with those used when the motor has attained its speed.

16. Give a rough sketch of a switchboard for a station with batteries and feeders and a three-wire system.

Answer.—See Fig. 4.

Note.—Only two balancing dynamos are shown, whereas large dynamos are usually connected across between the two outer wires. A convenient arrangement is also wanted for connecting any one feeder on to the charging side of the regulating switch.

18. What is the construction of an ohmmeter?

Answer.—An ohmmeter is an instrument for comparing the current which traverses a circuit of unknown resistance with that which is set up in a coil of known resistance when a similar E.M.F. is applied to both, thereby giving the resistance of the unknown circuit. The instrument consists of two coils placed one within the other, and at right angles to each other—one coil of low resistance being placed in series with the external circuit, and the other coil of high resistance is shunted across the terminals of the external circuit and series coil. Within the coils is a small magnetic needle, pivoted to revolve in the plane of the axes of both coils, and provided with an index arm. The needle takes up a position parallel to the field produced, which is the resultant of the two fields produced by

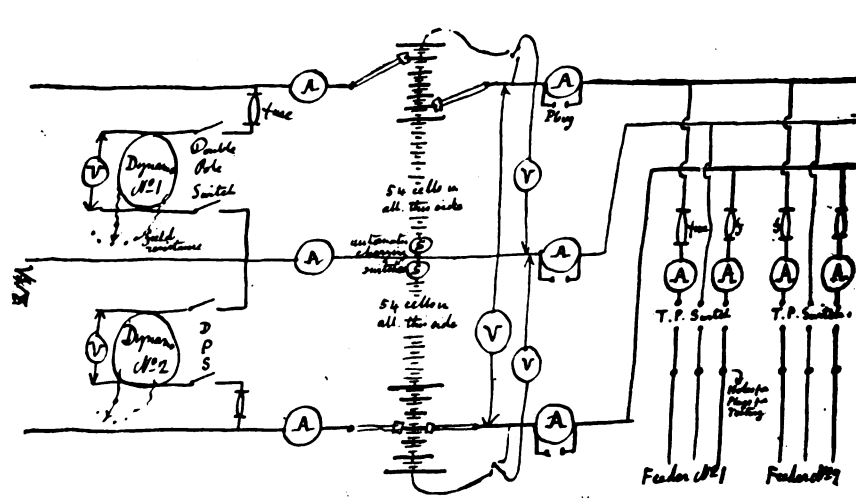

FIG. 4.

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the two individual coils. The scale is calibrated to some convenient unit of resistance. Sometimes there is a commutator supplied to place some of the turns in the series coil in parallel or series, thereby altering the sensitiveness of the instrument. The E.M.F. applied is usually produced by a small hand dynamo (say V = 100).

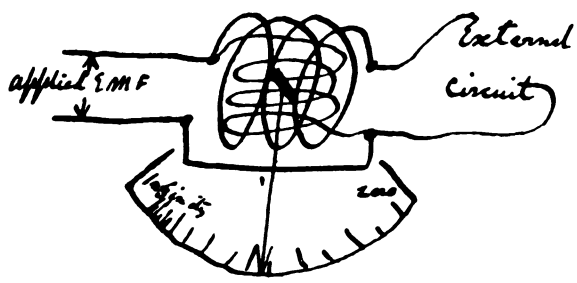

FIG 5.

20. How are the pull and self-induction of an electromagnet connected?

Answer.—The E.M.F. of self-induction of a given electromagnet is directly proportional to the number of turns in coil and to the magnetic induction in core. The turns being constant, the E.M.F. is $\propto$ to magnetic induction. The pull of the magnet is proportional to density of induction and proportional total induction, but density of $I = \frac{\text{Total } I}{\text{sec. area}}$; $\therefore$ as sectional area is constant, the density is proportional to induction, $\therefore$ pull is proportional to square of total induction.

$$\therefore \frac{\text{Pull of magnet}}{\text{E.M.F. of self-induction}} = \frac{I^2}{I}.$$

22. What magnetic quantities are denoted by the symbols H, B, and μ, and how are they related to one another?

Answer.—H denotes strength of magnetic field set up in air by a given magnetomotive force. B denotes strength of magnetic field set up in a given piece of iron when a magnetomotive force is applied which would set up a field, H, in air—*i.e.*, when iron is placed in field H in air the induction per square centimetre = B. $\mu = \frac{B}{H}$, and is called "permeability," and varies with the same sample of iron in various fields and with different samples of iron in the same field.

THE DOUGLAS AND LAXEY TRAMWAY AND SNAEFELL MOUNTAIN RAILWAY.

BY A TRIPPER.

Some little time ago, while paying a visit to the Isle of Man, I visited the Douglas and Laxey Tramway and the Snaefell line, just opened. Few people could realise, unless they had seen these lines, how immensely popular they are, neither would they credit the traffic which for a few months is carried and successfully coped with. Beyond this there is very little to excite those who have studied the question of electric traction, and this is disappointing to those who remember Dr. Edward Hopkinson's evidence before the Joint Committee on Protective Clauses, when he said that it was not only perfectly easy, but, in fact, a great economy to use a metallic return on tramways, and that he was then erecting such a line at Douglas. I suppose we shall never hear why, after many attempts, the earth return was finally adopted; but it is evident that the alleged simplicity and economy, though perfect in theory, were somewhat unruly in practice. We live and learn, and Messrs. Mather and Platt may live to bless the day when the Joint Committee discredited the evidence of their electrical adviser, when they equip, as I hope they will, some tramways under the existing Board of Trade regulations.

In the short time that I was able to spare to view this equipment I could not help feeling that the gods had favoured the contractors in this, I believe, their first attempt at tramway equipment, inasmuch as the conditions are so extremely favourable—first, in the permanent way, which consist of ordinary light steel rails, Vignoles type, flat bottomed, and spiked to cross sleepers, and, secondly, to the fact that the Board of Trade regulations are conspicuous by their absence. You therefore find some of the many conditions that rejoice the heart of the tramway manager, one of which is as much overcrowding in the cars as the trippers will agree to.

The cars are fitted with bogies. There are no outside seats, and each motor car is provided with two 15-h.p. motors and draws at rail car. The current is collected from the overhead conductor by means of a crossbar at each end of the car, the pressure of which is to a limited extent assisted by a spring; the conductor is generally very slack, and there is a considerable sag.

The Douglas and Laxey line has a generating station at each end, and a set of batteries of the chloride type near the centre. It would be interesting to hear authoritatively the practical results of these accumulators, the internal resistance of which would appear to be considerable. The rails are said to be bonded throughout. The method adopted is that of riveting two copper strips to the end of each rail under the flange, with a cross-bond at intervals; the exact value of this seemingly imperfect bonding will later on no doubt be fully determined.

The defects noticeable in another well-known installation of electric traction are also to be found here, the same amateur mechanical arrangements, the same disregard to profit by the experience of our American cousins, chief amongst which I noticed uncovered motors and gearing, courting as much detritus as the track will supply—to whose advantage?

In dismissing the tramway (so-called), and viewing the installation as a whole, one can only congratulate the company in the possession of a line where the margin between gross earnings and working expenditure is necessarily so large that they do not require an equipment which by the strictest economy only could pay a reasonable dividend.

The Snaefell mountain line also appears to obtain a large patronage. This is worked on the overhead system, and is similar in principle, as regards equipment, to the Douglas and Laxey. Its assistance enables you to reach the summit of the m untain by a line over four miles in length up a ruling grade of 1 in 12 to a height of 1,000ft., taking half an hour to do the journey. The permanent way is similar to the Laxey line, except for the introduction of a centre rail attached to the sleepers, on which an emergency brake can clip if required.

The cars, which seat I believe about 50 passengers, are equipped with four 25-h.p. motors, and they take the hill exceedingly well. In this case the accumulators are situated at the commencement of the line, the generating station being halfway up the hill. What is the benefit of having the accumulator-house so far from the generating station must be answered by those responsible. The whole of the return journey is done by gravity, and is at present unsatisfactory—it being exceedingly difficult to regulate the emergency brake clipping the rail to such a nicety that there is no jerking. What would naturally have suggested itself is the policy of using this descent for the generation of power with a corresponding economy. But as I have said before on these lines, there suggests to the uninitiated a reversal of the old saw, which will now read, "Take care of the pounds; the pence must take care of themselves."

THE NIAGARA INSTALLATION.

The following correspondence has taken place in the *Times*:

Sir,—Our attention has been called to a communication under date of July 15, from Prof. George Forbes, published in your columns. In view of the amazing statements of Prof. Forbes, we desire to give a few facts.

This company was not a submitter of plans in competition with others (as was Mr. Forbes) for prizes offered by the Cataract Construction Company in 1890, and it was not until a much later period that we became aware that Mr. Forbes had been a competitor and was continuing to

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labour for the honour of furnishing an acceptable plan for the transmission of power from Niagara Falls to distant points.

At the period named we were convinced that such transmission was not possible except by means of Mr. Tesla's great discoveries, whereby alternating currents of two or more phases could be used successfully for such purposes, and we naturally preferred to defer the submission of a plan until the Tesla inventions could be more fully adapted to so large an undertaking.

After a lapse of two years, and prior to the design of the dynamo referred to by Prof. Forbes, this company submitted to the Cataract Construction Company plans and specifications for a dynamo, with a system of distribution for the operation of arc lights, incandescent lights, street cars, and for electrolytic purposes, including rotary transformers. Full information and particulars were communicated to the engineers and officers of the Cataract Construction Company. Owing to the purloining of our plans by a rival company, and for other reasons, all tenders for generators were rejected by the Cataract Construction Company, who afterwards, in September, 1893, submitted to us plans for a 5,000-h.p. generator, saying that such plans had been prepared by their engineers, and asking us to make a tender for its construction and erection. A careful consideration of the plans submitted disclosed the fact that if constructed according to such plans the generator would be a failure, and this company thereupon refused to tender on the drawings and specifications presented. We, however, offered to accept the general form of generator and to redesign it so that it would be a perfect machine mechanically and electrically, and to submit new plans and specifications upon which the company would tender. This was agreed to by the Cataract Construction Company, and the generators now in use at Niagara Falls were built by us according to plans and specifications prepared by our own engineers. There is about the same difference between the machine designed by Prof. Forbes and that designed by us as there is between the picture of a man and the man himself—the appearance externally being very similar, but internally there is no resemblance whatever.

Business relations were established between Prof. Forbes and this company in 1888 by the purchase of his patent for a meter operated by hot air currents, and he was afterwards employed by us as an expert in a patent case, and in making tests on transformers. He thus had every opportunity to become acquainted with our practice and ideas in connection with the use of alternating currents for light and power purposes, and also had an opportunity to see considerable of the early work on the Tesla motors. That such opportunities were valuable to him is shown by the fact that the first plan submitted by him for the transmission of power from Niagara Falls was almost identically on the lines that we had laid out for such work and freely discussed with him.

The following letter was received from Prof. Forbes about October 1, 1891 :

34, Great George-street, London, S.W.,
Sept. 19, 1891.

Dear Mr. Westinghouse,—I am going to read a paper on alternate-current motors. I want to emphasise the importance of your work on the Tesla motors. May I ask you kindly to allow me to have as full information as possible by instructing one of your staff to forward some details? I daresay you cannot give me all the facts I want, but if I indicate them generally perhaps you will give me some of the points. First, and most essential, I want a drawing to show the winding of the armatures, especially the unsymmetrical winding, which I saw last year. I should also like to have drawings of the complete machines, generator, and motor. The dimensions, weight, speed of revolution, output, and efficiency of any particular machine that you have made. What are the largest and smallest machines you have had giving good results? What is the period of alternations and E.M.F. you have used? What examples may I quote of their successful use in practice? I know that the development of the motor has been retarded by other than engineering difficulties. I am glad to learn that the financial difficulties of the company have been surmounted.

With kind regards, I am yours most truly,

GEORGE FORBES.

P.S.—I also want facts about the power when starting the motor.

To which reply was made as follows :

Pittsburg, Pa., Oct. 30, 1891.

Prof. George Forbes, 34, Great George-street,
London, S.W., England.

My dear Sir,—I desire to apologise for not having written earlier in answer to yours of September 19. I have given the matter very full and careful attention, and I have come to the conclusion that our company cannot afford at this time to make public the information it has acquired in its work on the Tesla motor. The Tesla patents and discoveries include many very important matters, and his patents particularly cover the multiphase forms of motors and generators now attracting so much attention.

You must have become aware that patent rights are no longer respected in this country ; that whatever is brought out and fully explained is immediately availed of by unscrupulous competitors; and we now feel it is a matter of great importance to maintain for the present, and until we are well established, what are properly secrets of the trade. To no one would I sooner give the information asked for than to yourself, and I hope the day is not far distant when we will be able, with safety to ourselves, to meet your wishes in this respect.

Trusting that you will appreciate the reason given for not promptly comply with your request.

I am very truly yours,

GEO. WESTINGHOUSE, JR.

In consequence of Prof. Forbes having written the foregoing letter without stating that he was a competitor for the honour that would accrue to the successful designer of a complete plan, our company, for that and other good business reasons, refused to permit Prof. Forbes under any circumstances to visit its works or to have anything to do with the designing, constructing, or testing of the generators, and we are not aware that he has ever seen the apparatus which is now in operation at Niagara and for which he seeks to claim the entire credit.

In conclusion, we desire to state that a complete plant, showing the universal application of the alternating multiphase apparatus, was erected in our works for the especial benefit of the officers and engineers of the Cataract Construction Company in the fall of 1892, which Prof. Forbes did not see, but which was undoubtedly explained to him, and which he had an opportunity afterwards to inspect, and did inspect, in our exhibit at the World's Fair, Chicago, in 1893. In this exhibit, generators, motors, and rotary transformers were operated at 3,600 alternations per minute, being practically identical with the frequency actually adopted at the Falls, and very different from Prof. Forbes's recommendation of about 1,000 alternations per minute.

Prof. Forbes made a suggestion for a device for commutating currents, in place of a rotary transformer, which device was built, and upon test the fact was disclosed that it was not anything like as good as the rotary transformer which we had designed and which form was afterwards adopted by a rival company, as Mr. Forbes says, on his recommendation.

We regret that there is occasion for stating the foregoing facts.—Yours truly,

WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY
(Geo. Westinghouse, Jun , President).

Pittsburg, Pa., Aug. 29.

Sir,—In the *Times* of to day appears a letter from the Westinghouse Electric and Manufacturing Company, of Pittsburg, Pa., on the above subject. As silence on the part of Prof. George Forbes might be liable to misconstruction, I beg that you will permit me, his private secretary, to mention that he is far away from England, on a journey to South Africa on an important engineering work, and consequently it must be some weeks before he can have the opportunity of replying to the Westinghouse Company's letter.

In the meantime, I may, perhaps, be permitted to quote two extracts from letters written by (1) the Cataract Construction Company, through its president, Mr. Edward D. Adams, to Prof. Forbes, in November, 1894, and (2) the first vice-president of the same company, Mr. F. L. Stetson, which appeared in your columns of the 3rd ult., which I think sufficiently meet the principal contentions of the Westinghouse Company. Mr. Adams wrote :

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We further recognised that, in the advocacy of the use of the alternating current and of low frequencies, you were a pioneer, and we join you in the feeling of just satisfaction at the conclusion which has now been reached in respect of those features. In this, too, your independence of thought and action has been of particular service, while, through your original design of the stationary armature and revolving field of the generators, adopted by us, you have relieved us of one most embarrassing question in connection with the relation of the generator to the turbine.

Mr. Stetson, in your columns, said :

But the development of our plan must have been long delayed had it not been for the courage and comprehensive knowledge of Prof. Forbes, who alone stood for the absolute commercial advantage of the alternating current, and for his admirable conception of his 5,000-h.p. dynamo, so wonderfully worked out by the Westinghouse Company as to yield 5,315 h.p. in the actual test on June 28, 1895.

Prof. Forbes is entitled to the credit, as he must bear the responsibility, of the results of the advice given by him as to the three points stated in his letter of July 25 ; and we have followed his advice, perhaps not as far as his courage would carry him, yet beyond the former practice of the manufacturers, who now fully concur in the wisdom of his recommendations as adopted.

Two of the three points referred to by Mr. Stetson (which alone need be quoted here), as stated in Prof. Forbes's letter in your issue of July 27, are : "(1) The selection of alternating currents, and (2) the reduction of speed of alternations as low as was possible."—I am, Sir, your obedient servant, HERBERT E. MITCHELL.

34, Great George-street, Westminster, S.W.,
September 10.

ELECTROSTATIC VOLTMETERS.

We illustrate herewith two of Ayrton and Mather's electrostatic gravity voltmeters, made by Mr. R. W. Paul, of 44, Hatton-garden, London, E.C. The small-pattern instrument is constructed on the same principle as the standard or large pattern, for which the following claims are made : simple working parts, entirely

screened from outside electric and magnetic action, accurate calibration, perfect constancy, large open scale, dead-beat, absorbs no power, provided with safety fuses, fine workmanship and finish. The smaller meter is, however, simplified by the omission of the index-clamping device and of the magnet for damping.

The other meter is the spring control for low pressures. It is claimed to be correct for any frequency, and not affected by outside electric or magnetic action. The needle is of aluminium, balanced, and pivoted in jewelled centres ; the total weight of the moving part being less than 25 grains, it has a nearly dead-beat action,

and is free from creeping errors. All working parts are insulated from the case. Safety terminals are provided with fuses in capped glass tubes, which are accessible with the same readiness as those of the standard pattern. The scale is enamelled and clearly marked ; it is curved to a radius of 4in. and is 5in. long. The instrument may be screwed to a switchboard or stand upon a shelf. It is specially designed for central-station use.

THE INSTITUTION OF CIVIL ENGINEERS' PREMIUMS.

The council of the Institution of Civil Engineers invites original communications on the subjects included in the following list, as well as on any other questions of professional interest. For approved papers the council has the power to award premiums, arising out of special funds bequeathed for the purpose, such as the Telford Fund, the Manby Donation, the Miller Fund, the Howard Bequest, the Crampton Bequest, and the Trevithick Memorial Fund.

The council will not make an award unless a communication of adequate merit be received, but will give more than one premium if there are several deserving memoirs on the same subject. In the adjudication of the premiums no distinction will be made between essays received from members of the institution or strangers, whether natives or foreigners, except in the cases of the Miller and the Howard bequests, which are limited by the donors.

LIST.

The most economical methods of handling large masses of excavation, as exemplified in modern canal construction
The measures necessary for the improvement of cana navigation.
The methods adopted in carrying out large dock and harbour works, with descriptions of the plant employed.
The appliances for dredging and for removing rock in deep water, with details of the time occupied in the various operations.
The application of compressed air, steam, and hydraulic power to rock-drills.
The construction, equipment, and working of light or economical railways of a permanent character.
The design and construction of railway carriages, having reference to (*a*) lavatory accommodation, (*b*) provision for refreshments, and (*c*) sleeping arrangements.
The use of compressed air in subaqueous tunnelling.
The modern methods of pumping compared as to cost and efficiency.
The use of steel in the construction of large water-tanks.
The employment of storage reservoirs in irrigation and in the conservation of rivers.
The purification of sewage by precipitation, filtration, electrolytic, bacteriological, and chemical processes.
The use of ash-bin refuse in towns for the production of steam.
The purification of large quantities of water after its use in manufactories.
The methods of enriching coal gas and their effect on its calorific and illuminating values.
The production and enrichment of water gas.
The methods of conveying and of using natural gas.
The utilisation of heat (*a*) generated in the compression of air and other gases ; (*b*) carried away by steam-engine condenser water ; and (*c*) contained in boiler furnace flue gases.
The methods of condensing steam by the use of moderate quantities of water.
The theory and development of the compound steam-turbine.
The methods of removing moisture from steam, and of reducing losses by radiation from steam-pipes.
The production and use of super-heated steam.
The recent development in gas engines and oil-engines, including a comparison of the relative merits of the several cycles, with reference to "after-burning."
The application of oil and gas engines to tractive purposes on common roads and on tramways, and to the propulsion of vessels.
The design and construction of large turbines.
The methods of testing the lubricating values of oils, greases, etc.
The comparative merits of blast and reverberatory furnaces.
The influence of carbon on iron.
The magnetic properties of iron and steel.
The manufacture of steel for structural purposes.
The strength of steel shafts, tubes, and cylinders.
The mining of thin seams of coal.
The influence of coal-dust in contributing to colliery explosions.

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The efficiency of centrifugal fans for forced draught and for the ventilation of mines.
The underground arrangements in collieries.
The drainage of mines by pumping and by tunnelling.
The extraction of metals from their ores by electrolytic processes.
Argentiferous lead smelting in water-jacketed blast furnaces.
The methods of gold-mining in California.
The occurrence, production, and uses of (*a*) asbestos, (*b*) arsenic, and (*c*) mercury.
Aluminium, its manufacture, properties, uses, and alloys.
The metallurgy of chromium, molybdenum, and other rare metals, and their use in the manufacture of steel.
The design, construction, erection, and working of modern stamp mills.
The machines for raising mineral tailings, as lifting wheels, pumps, dredgers, etc.
The most suitable steam-power equipments for electric light stations.
The utilisation of electric lighting plant during hours of small demand.
The utilisation of electrical energy in the form of heat.
The regulation of electric pressure in large lighting circuits as carried out at the engine, the dynamo, or the exciter.
The theory and practice of the transmission of power by alternating currents.
The use of electrical motors for driving machines in textile factories and in engineering workshops.
The first cost, facility, and economy of operation of electrical traction on railways with heavy trains and on tramways.
The construction and working of electrical lifts and cranes.
The electrolytic action of return currents in electrical tramways on gas and water mains, and the best means of providing against electrical disturbances.
The most suitable alloys for the working parts of pumps for lifting corrosive liquids from mines, etc.
The methods of preventing or arresting the corrosion of hydraulic rams of large diameter.
The use of the die-press in workshop operations.
The modern rolling mills of the United States.
The appliances used in the manufacture of smokeless powder.
The transport, storage, and manipulation of grain.
The different systems of refrigeration, and of appliances for the storage and preservation of food produce.
Brine-pumping and the manufacture of common salt.
The present limits of speed at sea.
The relative advantages of single screws, of twin screws, and of triple screws in large vessels.
The use of electrical machinery for lighting and the transmission of power in warships and in the mercantile marine.
The most recent types of (*a*) passenger and mail steamers, (*b*) cargo steamers.
The best position for torpedo-discharging tubes on large vessels, with a fixed direction, or trainable.

The communications must be forwarded to the Secretary, the Institution of Civil Engineers, Great George-street, Westminster, London, S.W., from whom any further information may be obtained. There is no specified date for the delivery of MSS., as when a paper is not in time for one session it may be dealt with in the succeeding one.

THERMODYNAMICS OF GALVANIC POLARISATION.

Messrs. Hans Jahn and Otto Schönrock, in *Zeit. Physikal. Chem.*, develop from the thermodynamical standpoint, formulæ for the cathodic, anodic, and total polarisation for a solution. From these it is indicated that if the potential difference between a metal and its solution be substracted from the total polarisation, the difference should be constant in the case of the strong oxy-acids, a result agreeing with experimental data. The E.M.F.'s of various chains are also calculated and compared with the found results. Under similar conditions all oxy-acids should show the same potential difference at the commencement of the gas development, a result experimentally obtained by Le Blanc. The polarisation should be independent of the concentration, and experiments with sulphuric acid gave the following results: normal solution 2·3977 volts, decinormal solution 2·3922 The nature of the electrode affects the polarisation; the size, however, should not affect the final value. In the case of salt solutions, similar laws obtain, the polarisation increasing with the polarising E.M.F. and being independent of the concentration. The polarisation of dilute solutions of bases should be equal to that of dilute acids, and this conclusion is verified by experiments with solutions of potassium and sodium hydroxides, ammonia, ethylamine, and diethylamine.

LEGAL INTELLIGENCE.

THE DUBLIN AND KINGSTOWN ELECTRIC TRAMWAY.
Application for an Injunction.

On September 10, in the Exchequer Court, Dublin, before Mr. Justice Murphy, sitting to hear vacation motions, the Pembroke Township Commissioners appeared to apply for an interlocutory injunction restraining the Dublin Southern District Tramways Company, by themselves or by their servants or agents, from entering upon and breaking up, opening, or excavating the roads or pathways of the township alongside their tramway. The motion was listed for hearing on a previous day, but it was then postponed for the present sitting.

Messrs. Piers F. White, Q.C., A. F. Elood, and T. C. Drury (instructed by Messrs. D. and T. Fitzgerald) appeared for the Pembroke Commissioners. Messrs. D. B. Sullivan, Q.C; Thomas O'Shaughnessy, Q.C.; and R. H Sheil (instructed by Messrs. O'Connor and Dudley) appeared for the Dublin Southern District Tramways Company. Counsel for the contractors (The British Thomson-Houston Company, Limited), Mr. John Gordon, Q.C. (instructed by Messrs. Casey and Clay).

Mr. White, Q.C., in opening the case, said the Commissioners had control of the roads in the township, and the Act under which the tramway line was being constructed (the Tramways Act of 1893) gave no power whatever or right to the defendants to place electric wires underground. The only power under that Act which the defendants had for breaking up the roads was for the purpose of putting down poles to carry overhead wires. The defendants proposed to dig up the township roads and lay down cables and wires, although when the Bill of 1893 was before Parliament an undertaking was given by the defendants in the course of negotiations that only an overhead system of wires would be adopted. Mr. Fitzgerald, the solicitor to the Commissioners, had made an affidavit in which the nature of the negotiations was fully set out. An affidavit had been made by Mr. Robertson, the defendants' secretary and manager, in which it was stated that the overhead wires were, of necessity, small, and consequently they were insufficient to carry a continuous or even current along the whole line This difficulty would be got over by feeders of much larger dimensions and less resistance running from the power-house underground, and connected at regular intervals of half a mile with the overhead wires. There Mr. Robertson stated that the overhead wires were not sufficient for their purpose, and it was, in consequence, proposed to break up the township roads, dig trenches in them, and lay in the trenches so dug wires of much greater diameter than those running overhead. That would be all very well if the defendants had power to carry it out, but they had no power under their Act to break up the public roads. They could not do that without having entered into a contract with the Commissioners in the first instance, and no such contract had been entered into.

Mr. Justice Murphy said it was a serious thing to interfere with the rights of the Commissioners; but, on the other hand, it would be a serious thing to interfere with and prohibit the execution of the works. It would be a serious thing for an order to that effect to be made by a judge who would not ultimately try the case. Of course, if by the act of the defendants irreparable injury would be done or likely to be done, that might and would demand immediate action on his (Mr. Justice Murphy's) part by injunction. But, on the other hand, if any injury resulting from the action of the defendants or either party would not be of an irreparable character, compensation could be made for it at the trial when the case came before the Master of the Rolls or the Vice-Chancellor.

Mr. White: Of course, the question of convenience or inconvenience is a serious one.

Mr. Justice Murphy: It must be irreparable injury.

Mr. White: What we proposed to the defendants was that they should enter into an undertaking to keep us harmless and indemnified against all actions and demands instituted or made on behalf of any person, firm, or corporation in respect of loss damage, or injury sustained, or alleged to be sustained, in consequence of the opening or breaking up of any such streets or roads as aforesaid; and, further, that the defendants should in any such action be joined as third or indemnity party within the meaning of the rule of the court. Defendants declined to enter into that agreement, and they entered upon the roads in, as we allege, the capacity of trespassers, and proceeded to dig trenches in them.

Mr. O'Shaughnessy: And your men by violence prevented us.

Mr. White: Men were sent to throw the earth back into the trenches. The defendants said that the Blackrock and Kingstown Commissioners consented to the putting down of the cables and

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wires; but that could not settle the question of law raised in this case. Besides, it was not known what inducements had been held out to the Kingstown and Blackrock Commissioners to procure their acquiescence and consent. The Commissioners relied, as they had a right to rely, upon their contract that nothing shall be put up in their township but the overhead wires. If the defendants had not taken sufficient powers by their Act they should go back to Parliament again, but at present they were not in a position, for they had not the power to enter upon and break up the roads under the control of the Commissioners On the present motion it was only necessary for his Lordship to be satisfied that there was a case to be tried. The most serious accidents to life and property might result if underground cables and wires were laid down, and if the defendants persevered with the work they might, and no doubt would, do acts which would be entirely irreparable. The balance of convenience was, therefore on the side of the Commissioners, and in favour of an injunction, and even the test of irreparable injury was, he submitted, in their favour. An injunction, he submitted, should be granted.

Mr. Sullivan, Q C., replied on behalf of the tramway company, and said in applications of this kind for an interlocutory injunction, an element of great importance, and to which great weight was always given, was the extent of the loss, damage, or inconvenience which might be caused by the granting of the injunction He was surprised to hear it stated on the other side that loss to an enormous extent would not result from the granting of this injunction. In one of the affidavits it was stated that if the Court granted the injunction against the defendant company it would render the Act of 1893 a complete nullity, preventing the opening of the line for traffic, and occasioning an enormous loss on the company and the contractors. He charged the statements made in the plaintiffs' affidavits as not being made *bonâ fide* This serious loss and damage must result beyond doubt If the injunction were not granted the line could be completed by October 1, and the roadway restored to its ordinary condition. But at present 200 men had been flung out of employment, and would be kept out of employment until January or November if this application were granted. The company had spent already on these works £130 000. In his opinion that was very strong evidence that great loss and inconvenience would result from the granting of this application The line had been completed through Kingstown, and there never was a suggestion of any difficulty or danger while that work was being done, or likely to result after it was completed. The result was this, that the feeders had been laid down in every part of the line, except in the Pembroke township, and the line could not be completed in its entirety if this injunction were allowed to go . Without the construction and laying down of the feeders, the system could not be worked, and, if his Lordship granted the application, it would paralyse the line for at least two or three months, at great loss and to the serious inconvenience of the public, because the roadway could not be properly laid until the work was finished, and it could be finished if now allowed to go on within the time he had mentioned. There were grave and serious questions of law involved in the case. They said the acts complained of were necessary to the exercise of the statutory powers given to them. The powers given to them were to construct an electrical tramway by the system of overhead wires, and this power could not be properly exercised without laying down these feeders in the manner he had described. The feeders were of such a size, weight, and capacity that it would be impossible to carry them overhead. They were an integral part of the system mentioned in the Act, and without them the line would be inoperative. There was no human probability of any serious damage being occasioned by these works, and if any did occur the company were willing to take the fullest responsibility for it, and they would be a good mark for any pecuniary damages that might be awarded against them. These underground wires were properly insulated and armoured and could not be broken into. They were as harmless when laid in position as an ordinary bar of iron, and to say that a pick or crowbar coming into contact with one of them would entail serious consequences to the workman was absurd There were 300 lines of this sort laid in the United Kingdom, and it never occurred to anyone across the water that any danger would occur from their use Five and a half miles of this line had been laid from Dalkey through Kingstown and Blackrock, and it never occurred to the people of these townships that there was any danger. He asked the Court to refuse the motion.

Mr. O'Shaughnessy Q C., followed on the same side, and said similar cables to those complained of were laid under the pavement in the principal streets of Dublin for electric lighting, and no complaint had ever been made and no damage had ever been caused Dalkey, Kingstown, and Blackrock townships had also made no complaint. The overhead wires were, in his opinion, unsightly, and it would have been more in the way of common sense if the Pembroke Commissioners had opposed the erection of these than in the laying of the underground wires.

The injunction was refused.

COMPANIES' MEETINGS.

ELECTRIC CONSTRUCTION COMPANY, LIMITED.

The second annual general meeting of this Company was held yesterday at Winchester House, E.C.

The **Chairman** (Sir Daniel Cooper, Bart., G.C.M G.), who presided, said that the report and accounts, if not so satisfactory as they could wish, showed a considerable improvement as compared with those submitted last year, and gave good promise for the future, for the manufacturing profit of the year amounted to £31,814. 12s 7d., against £25,754 10s. 5d last year. The net profit of £12,091. 10s. 3d the directors recommended should be appropriated in payment of the full preference dividend, and the balance of £10,134. 15s. 10d carried forward to the credit of next year's account. The profit had all been fairly and hardly earned, and might properly be applied in payment of a dividend on the ordinary shares, but their available capital was barely adequate for the development of the business, and at the same time to do justice to the debentures and shares in other companies inherited as a legacy from the old corporation. That was the sole reason that moved the directors to the conclusion that it would be for the advantage of the Company, and ultimately in the interest of the shareholders, to make no distribution of dividend at present. Some of the Board were amongst the largest shareholders, and no doubt would be greatly pleased to have a dividend, not merely for the sake of the money, but from the credit arising from the paying of a dividend, but they were satisfied that in the long run it would be more to their credit as directors and advantage as shareholders to build up the business on broad, solid foundations. They asked the shareholders to have a little further patience, feeling confident that their forbearance would meet a due reward. The accounts were clear and explicit, but he would invite attention to those items which specially indicated the position and progress of the Company. The profit and loss account showed working expenses reduced fully £2 000. Their hopes of further improvement were in the direction of getting better results from their expenditure The depreciation account had been credited with £5,000 out of revenue, as compared with £3,000 last year. After some experience they hoped to reduce this sum. On the credit side of the account, the gross manufacturing profit amounted to £31,814 12s 7d , over £6,000 more than last year Such profits were strong evidence of the remunerative character of the business in which the Company was engaged. Coming to the balance sheet, on the assets side of the account £1 940 2s 6d. had been added to the property account for additions to plant and buildings, which would enable them to turn out more work. The old property of the Company in Commercial road, Wolverhampton, had been sold, and the price obtained for the property (£2,500) had been handed to the trustees of the first mortgage debentures and invested for the benefit of the debenture-holders On the account "shares and debentures in other companies" the total debit remained practically the same as last year. He believed that as the various undertakings developed the amount at debit of the account would be fully realised The installations completed during the year had been entirely successful, and confirmed the reputation of the Company for first-class work. The Chairman then referred to work being carried on at Clerkenwell and Hartlepool (details of which were given in the directors' report published in our last issue) The directors were pleased to be able to report that their relations with the workmen at Bushbury were of a highly satisfactory character. Now that the works were completely organised under the supervision of their manager, Mr. Blackburn, and the most competent staff that could be had, the out-turn of work was increasing and its quality maintained their high reputation for skill and workmanship. The best evidence of this was that they were full of orders for the next six months. In these circumstances the directors had now intimated a moderate advance in prices, such as was fully justified by the advance in materials and the improved prospects of trade. With electrical plant it would be found even more certain than in the case of other machinery that the best was the cheapest. The prices would compare with those of other makers of first class machinery, but they declined to sacrifice quality to cheapness. Much advantage could not be expected from the new prices during the first half of the year; the benefit would accrue later on. The general position of the Company had materially improved during the year, and he fully expected to be able to submit next year a report and accounts showing still greater improvement. Speaking as one largely interested in the Company he had now more confidence in its management and in the profitable character of its business than at any previous period of its existence.

The **Chairman** then formally moved the adoption of the directors' report and accounts which was seconded by **Mr. J. W. Barclay** (deputy-chairman) and carried unanimously.

In reply to a shareholder it was stated that the Hartlepool tramways would be worked on the overhead system.

The retiring directors (Messrs. J. W. Barclay and J. I. Courtenay) and the auditors (Messrs J. Meeston and Co.) were re-elected, and the meeting closed with the usual votes of thanks.

BRIGHTON AND ROTTINGDEAN SEASHORE ELECTRIC TRAMROAD COMPANY.

A meeting of the directors and shareholders of this Company was held last Friday at the offices, Madeira-road, Brighton.

Mr. E. O. Bleackley (chairman of directors) presided, and explained why the line would not be opened this season, as they had confidently anticipated it would be when they last met there. As usual, the cause of the delay was the Corporation of Brighton, in which body there was unfortunately a strong party who had done everything in their power from the very beginning to damage and thwart the undertaking, and delay its completion in every possible way.

The **Chairman** moved and **Mr. J. J. Clark** seconded, a resolution authorising the issue of debentures, and the motion was carried unanimously, after complaints had been made that the Town Council had insisted on another diversion of the line.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Alexandria.—The municipal authorities of Alexandria, Egypt, invite applications by October 1, 1895 for the concession of the tramway lines from St. Catherine Place, through the outer boulevards, to the projected abattoirs at Mex, with a branch line. Security £E1,000.

Paris.—The Direction Générale des Postes et Télégraphes invite tenders by September 16 for making two air-conduits for the pneumatic telegraph service. The Cahier des Charges may be seen at rue de Grenelle, No. 103 (division du matériel et de l'exploitation électrique, 3ME bureau).

Braila.—The Municipal Authorities of Braila, Roumania, invite tenders by October 2 for the construction and working of a system of electric tramways in the city. Provisional security, 10,000f This contract was originally fixed for July 29. Tenders are further invited by the Municipal Authorities of Braila for the lighting of the city by electricity or by electricity and gas. Provisional security 10,000f.

Huddersfield.—Tenders are wanted for the lighting by electricity of the boot and shoe and confectionery departments, reading-room, library, etc., in John-street and Albion-street, Huddersfield, for the Huddersfield Industrial Society, Limited. Specification may be obtained at the office of Mr. J. Berry, architect, 9 Queen-street, Huddersfield Tenders to be delivered at the society's office, Buxton-road, by 4 p m. on 16th inst.

Harrogate.—The Corporation of Harrogate invite tenders for wiring the new Montpellier Baths for electric lighting. Specifications and full particulars may be obtained of Messrs. Baggallay and Bristowe, architects, 66, Conduit-street, London, W., on payment of £1 1s., returnable on receipt of bona fide tender. Sealed tenders, endorsed "Tender for Wiring New Baths," are to be sent to the town clerk, Municipal Offices, Harrogate, by September 30.

Chepping Wycombe (Bucks.).—The Urban Sanitary Authority for this borough are prepared to receive tenders from public companies for working the electric order obtained by them within the borough for a term of years and upon approved conditions. Tenders are to be delivered by noon on October 14 next, at the office of the town clerk, High Wycombe, where a copy of the electric order may be seen and further particulars obtained. The Authority do not bind themselves to accept any tender.

Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

Shoreditch.—The Shoreditch Vestry invite tenders for—Section A—insulated electric mains; Section B—conduits and drawing in boxes; to be laid in the parish of Shoreditch. Specification, with form of tender, can be obtained from the consulting engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of three guineas, which will be returned on receipt of a bona fide tender. Tenders, endorsed "Tenders for Electrical Mains," to be sent by 17th September to Mr. H. Mansfield Robinson, vestry clerk and solicitor, Town Hall, Old-street, E.C.

Gravesend.—Tenders are requested for the supplying of a telephone, and providing, delivering, and fixing, etc., of the necessary poles, wires, instruments, and plant at regulation distance of a specified description, from the sanatorium to the office of the sanitary inspector and the police station, for the Town Council. Tenderers are also requested to specify an amount per annum at which they would maintain the communication. Further particulars can be obtained of the sanitary inspector, Town Hall. Tenders, marked "Sanatorium Telephone," must be delivered to Mr. Chas. E. Hatten, town clerk, Gravesend, by September 20.

London, E C.—Tenders are requested for the following, for the Shoreditch Vestry: (Section A) insulated electric mains; (B) conduits and drawing-in boxes, to be laid in the parish of Shoreditch. Specification, with form of tender, can be obtained from the consulting engineers, Messrs. Kincaid, Waller, and Manville, 29 Great George-street, Westminster, on payment of £3 3s., to be returned on receipt of a bona fide tender. Trades union rates of wages and hours of labour to be observed. Sealed tenders, endorsed "Tenders for Electrical Mains," to be sent by 4 p m. on 17th inst. to Mr. H. Mansfield Robinson, vestry clerk, Town Hall, Old-street, E C.

Stafford.—The committee of the Staffordshire County Infirmary invite tenders for wiring and fitting the infirmary for electric light. Tenders, sealed and addressed to the Secretary, Staffordshire County Infirmary, Stafford, and endorsed "Tender for Electric Lighting," must be received by him not later than noon on September 14. Copies of the specification, with form of tender attached, can be obtained from the secretary on payment of £1, which will be returned on receipt of a bona fide tender; and plans may be seen on or after Monday, September 2, at the infirmary, or at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George street, London, S W.

Dewsbury.—The Corporation invite tenders for wiring the Public Baths and Library. Forms of tender and copies of specification may be obtained from the borough electrical engineer, Electricity Offices, Bradford-road, Dewsbury, on payment of £1. 1s., which will be returned on receipt of a bona fide tender, together with the specification. Plans may be seen at the office of the borough electrical engineer, Bradford-road, Dewsbury, from whom any further information can be obtained. Sealed tenders must be sent to Mr. E Mawdesley town clerk endorsed "Electric Lighting, Public Baths and Library," not later than 12 noon on Saturday, the 21st inst.

Dundalk.—The Dundalk Town Commissioners invite tenders for erection of an electric lighting installation for the purpose of lighting the town by electricity on or about July 1, 1896, reserving to themselves the right of taking over the plant at the end of a term of years—this term to be stated in the tenders. The successful contractor to have the right of supplying private consumers, while the Commissioners will pay a fixed sum yearly for the town lighting—this sum to be stated in the tender also. The Commissioners have obtained a license from the Board of Trade for supplying electric lighting. Tenders will be received by Mr. Edward Farrar, town clerk, Town Hall, Dundalk, up to October 7.

Queenstown (Ireland).—Tenders are invited by the Queenstown Town Commissioners for the lighting of Queenstown by electricity (private as well as public) as per report and specification of Mr. R. Hammond, M.I.E.E., Ormond House, London. Tenders are also invited as follows: the contractor to provide the capital for the due erection of the works and maintenance thereof as per above plans and specifications, on being guaranteed the public lighting, and a stipulated number of private lights (to be agreed upon), the Commissioners having the right to purchase within a specified period. Plans and specifications are deposited at the Hall, Queenstown, and can be inspected there between 11 and 2. Tenders must be lodged with the town clerk, Queenstown, marked "Tender for Electric Lighting," by 2 p.m. on September 16. Further particulars and conditions to be had on application to Mr. James Ahern, town clerk, Queenstown.

Belfast.—Tenders are invited for the supply and erection of two direct coupled steam-engines and dynamos, battery of accumulators, main switchboard, and installation of about 232 incandescent lamps, complete, for the lighting of Belfast Lunatic Asylum, for the Commissioners for the Control of Lunatic Asylums. Tenders should be sent in a sealed envelope, endorsed outside "Tender for Works for Lighting Purdysburn Asylum," and addressed to the secretary, Board of Control, Custom House, Dublin, and accompanied by a separate sealed envelope, similarly addressed and endorsed, containing the detailed estimate. Forms of tender will be issued on application to the office of the Board of Control of Lunatic Asylums, Custom House, Dublin, on deposit of £1. which will be returned to all persons who have sent in bona fide tenders Plans and specification can be seen at the office of Mr. O A H. M'Cowen, Chapel-lane, Belfast. Tenders by 10 a m. on 28th inst.

Manchester.—Tenders are invited for the execution of the following works, for the Manchester Corporation—(Contract 2) laying a system of underground telephone pipes, with brick inspection pits, service boxes, and other appurtenant works in the following streets: route 6—Little Peter-street, Chester-road, Hulme Hall-road, to a point adjoining the Ship Canal. Laying a system of underground telephone pipes with brick inspection pits, service boxes, and other appurtenanant works in the following streets (Contract 3)—viz.: route 1—Dickenson street, South-street, Jackson's-row, Deansgate, Atkinson-street, Byrom-street, Camp-street, Charles-street; route 2—Dickenson-street, George-street, Nicholas-street Booth-street, Tib lane, Cross street, South King-street, Deansgate, Lower King-street, Ridgfield, John Dalton-street; route 2A—Pall-mall, Moult-street, Bank-street, Half Moon-street; route 2B—Bank-street, Exchange-street, St. Mary's-gate, Blackfriars-street, Parsonage; route 3—Faulkner-street, Charlotte street, Back George-street; route 3A—Charlotte-street, Fountain street, Marble-street, High street, Cannon-street, Hodson's-square; route 3B—High street, Nicholas croft, Bradshaw-street, Cross-street, Balloon-street, Holgate-street, Corporation-street, Mark-lane. Drawings may be seen, and copies of specification, bills of quantities, and forms of tender for each contract may be obtained on application at the city surveyor's office, Town Hall, Manchester, on September 9, on payment of £2. 2s. and £5. 5s. respectively, which sums will be refunded on the return of the documents and the receipt of bona fide tenders. Sealed tenders, enclosed in the official envelopes, to be sent in by 5 p.m. on September 17. The Corporation also invite tenders for the supply of about 15 tons of copper strip. Specifications and forms of tender can be obtained on application (in writing only) to Mr. C. Nickson, superintendent, Gas Department, Town Hall, Manchester. Tenders to be sent in not later than 10 a m. on the 20th inst.

RESULTS OF TENDERS.

Witton Gilbert (Durham).—The Parish Council have accepted Messrs. Crompton's and Charlaw Colliery Company's tenders for lighting the whole parish of Witton Gilbert by electricity at 33s. per lamp, 4s. 6d. a lamp cheaper than by gas.

Worcester.—The City Council have accepted the Brush Company's offer to supply and fix two 36-kilowatt transformers for the waterworks motors in lieu of the 30-kilowatt transformers originally supplied at £25 on condition that the company give a written guarantee that the larger transformers will be sufficient for the purpose, and that they will maintain them in good working order for two years without charge.

Ayr.—The following tenders have been received by the Police Commissioners for wiring the municipal buildings, public library, and police offices, and furnishing the necessary fittings—viz.:

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Wiring.

Name of firm.	Town Hall. £ s. d.	Carnegie Library. £ s. d.	Police Offices. £ s. d.	Total. £ s. d.
Mavor and Coulson...	--	—	—	875 0 0
Electrical Installation Company	—	—	—	840 19 0
Anderson and Munro	378 12 4	187 12 11	100 16 8	667 2 3
Faraday Electrical Engineering Company, Limited.....	285 0 0	153 0 0	99 0 0	537 0 0
A. Macleod and Co	246 8 10	128 14 2	63 12 2	438 15 2
L. H. Heywood.....	301 0 0	153 0 0	80 0 0	434 0 0
L. B. and A. Auld...	228 10 6	116 3 0	59 3 0	403 16 6
Scottish Electrical Engineering Company	—	—	—	388 8 4
W. G. Higgs and Co. (accepted)	157 16 0	80 8 0	42 0 0	280 4 0

Fittings.

A. Macleod	495 0 9	179 16 7	58 14 0	733 11 4
W. G. Higgs and Co.	205 0 0	108 0 0*	33 0 0	346 0 0
Faraday Electrical Engineering Company, Limited.....	220 5 0	70 10 0	28 2 3	318 17 6
Anderson and Munro	195 8 6	96 11 6	17 16 0	311 16 0
Electrical Installation Company	—	—	—	298 10 0
Scottish Electrical Engineering Company	—	—	—	292 0 0
B. Verity and Sons (recommended for acceptance)	—	—	—	258 9 2
L H. Heywood	155 0 0	40 0 0	—	195 0 0
L B and A. Auld...	—	—	—	quote items.
Mavor and Coulson	—	—		not quoted for.

* £65 less if existing fittings be adapted.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3 026.

Personal.—Mr. E. G. Pink has been appointed by the Ayr Town Council electrical engineer at a salary of £200.

Nerden (Lancs.).—The question of introducing the electric light was raised at the last District Council meeting.

Middleton.—The Town Council have decided to memorialise the Board of Trade for a provisional order empowering the Council to adopt the Electric Lighting Act for the borough.

Suter Hartmann and Rahtjen's Composition Company, Limited.—We are informed that Hartmann's paint for iron and wood has been adopted for recoating the electric light posts in the city of London.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 8th inst. amounted to £1,324, as compared with £1,054 in the corresponding week of last year, being an increase of £270.

Walsall.—The works for the supply of electric light to the town are now in a forward state, and it is anticipated that the new illuminant, for which over 1,000 lights have already been prepared, will be ready at the commencement of next month.

Electrical Instruments.—We have received a copy of the catalogue of electrical testing and measuring instruments manufactured by Mr. Robt. W. Paul, of Hatton-garden, London. It is very complete, well illustrated, well printed, and well indexed.

Barnet.—Mr. Bampfield has given notice that at the next meeting of the Urban District Council he will move that the Council consider in what way the question of electric light can be dealt with so as to satisfy the requirements of the provisional order.

Eastbourne.—The Eastbourne Electric Light Company having requested permission to extend their mains in Terminus-road and South-street, the Town Council have resolved that the application be granted subject to the works being carried out in October next.

Runcorn.—The Rev. Dr. Garcaldi has given notice that at the next Urban Council meeting he will move that it is in the interest of the ratepayers of Runcorn that the electric light be introduced in the town, and that a committee be appointed to carefully consider the subject.

Burton-on-Trent.—The report of the Gas and Electric Light Committee of the Town Council states that the manager of the gasworks has been instructed to report to the committee as to the desirability of lighting the streets with the electric light where the mains are laid for electricity.

City and South London Railway.—The returns for the week ended September 8 were £839, compared with £840 for the corresponding period of 1894, being a decrease of £1. The total receipts for the half-year 1895 are £8,509, compared with £8,576 for the corresponding period of 1894, being a decrease of £67.

Longton (Staffs.).—The Mayor, with other gentlemen, has been appointed a sub-committee to prepare the necessary details for the provisional order with reference to the extension and working of the tramways in the borough, and to conduct the negotiations for the working of the same, with full power to deal with the matter.

Ayr.—During the year there has been borrowed by the burgh for electric lighting £3,750, and of that there has been spent for the cost of the provisional order, site, and other expenses, £2,917, leaving £832 still at credit. During the present year a considerable sum will be required, and provision has already been made to borrow the requisite amount.

Bury.—At the last meeting of the Town Council Alderman Brierley moved the adoption of the Electric Lighting Committee's minutes, which consisted of the passing of the accounts. The proposition having been seconded, Councillor W Sykes thought that they might have considered the question of electric lighting. The Mayor: We are not taking any harm by waiting.

Altrincham.—Mr. Newton moved at the Urban Council meeting that the Highways Committee obtain tenders for lighting their offices and also the Market-place with electricity and submit the same with their recommendation to the next meeting of the Council. Mr. Boyd seconded the motion. Mr. J. Drinkwater said he thought that the company intended to light the Market-place for nothing.

East Grinstead (Sussex).—The General Purposes Committee of the Urban Council have reported that they could not at present recommend the Council to bind themselves in any way in the matter of the electric light, but they suggest that Messrs. Owen, Pike, and Co. should be informed of the number of public lamps. A letter has been received from Mr. W. Howard Tasker offering his services as electrical engineer.

Swansea.—The scheme for lighting the main streets of Swansea by electricity, and at the same time using the plant for the purpose of destroying the town refuse, is now complete. The Corporation Committee have finally considered the report, which will be presented to the Corporation at its next meeting for consideration and adoption. The work, which is to be turned out under the guidance of Mr. Manville, will cost about £50,000.

Liverpool.—The Waterloo District Council have received the following communication: "Liverpool Gas Fittings Company, Limited, 126A, Duke street. Liverpool, August 24, 1895. To the Chairman, the Waterloo Local Board, Waterloo. Dear Sir,—Having heard that you contemplate installing the electric light at your Town Hall, we shall be very glad to submit a tender for same if you will kindly forward us the specification.—Yours faithfully, JOHN HAYNES."

Cork.—Mr. O'Toole has reported to the Waterworks Committee of the Corporation that he had gone into the question of lighting the waterworks with electricity, and after allowing for the upkeep of plant, etc., there would be a saving each year sufficient to pay principle and interest of the plant in at most five years, and after that period probably the saving would be £50 a year. It has been decided to ask a Dublin firm to supply a specification of the plant that would be required.

Weybridge.—There was a long discussion at the last meeting of the Urban District Council on the question whether the town should be lighted by gas, oil, or electricity. The chairman and a committee had entered into a contract with the gas company, but it was argued that they had acted *ultra vires*, and a strong preference was expressed for the electric light. Ultimately, however, as a recission of the contract might probably result in legal proceedings, nothing was done.

Eccles.—The Town Hall, Tramways, and Electric Lighting Committee of the Town Council have reported that a circular was received from the Town and Village Electric Light and Power Company, Limited, in which it was stated that the company were prepared to erect, on land owned by the Corporation, a complete installation for public lighting by electricity, lay mains for private lighting, etc. The communication was ordered to be passed on to the consulting electrical engineer.

Thames Valley Launch Company, Limited.—This Company has been registered, with a capital of £10,000 in £5 shares. Object: to acquire the business of a launch and boat builder, electrical and general engineer, etc, as now carried on by the Thames Valley Launch Company at Weybridge and elsewhere; to enter into an agreement with W. R. Edwards, and to carry on the above business in all its branches. The directors are S F. Beevor and W. R Edwards. Registered office: Riverside Works, Weybridge, Surrey.

Bradford.—In connection with the oil-gas experiments, the Gas and Electricity Committee of the Corporation recommend that "after full trial of the apparatus and process patented by Dr. Dvorkovitz for the enrichment of gas by oil, and after careful consideration of reports by Mr. Lewis T. Wright, the expert called in to advise on the matter, the committee find that the experiment has not proved such a success as to warrant the adoption of the system by the Corporation, and that the Council be accordingly recommended to abandon the scheme."

Westralian Electric Lighting Supply Company, Limited.—This Company has been registered with a capital of £80 000 in £1 shares. Object: to adopt and carry into effect an agreement made September 3 between Westralia, Limited, of the one part and this Company of the other part; to generate, store and distribute electricity or any other agency for the purpose of lighting public or private buildings factories, mines, public streets, omnibuses and other vehicles, lighthouses, railways, and for other purposes, and to act as electricians and electrical engineers generally in West Australia or any other part of the world.

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Halstead (Essex).—A letter having been read from the manager of the gas company at the Urban Council meeting with reference to the price of gas, in which he stated the directors did not see their way clear to make any reduction at present, Mr. Clark said a temporary agreement might be come to for the present with the company, and in the meantime enquiries might be made in various towns in the neighbourhood, and also as to the probable cost of substituting electricity. He referred to a case at Thetford (Norfolk), where the cost of starting the electric light was only £3,000. The question was referred to the Lighting Committee

Aberdeen—The Watching and Lighting Committee of the Aberdeen Town Council have discussed a suggestion, emanating from Mr Blackman, electrical engineer to the Corporation, to provide additional electric lighting in the streets. Mr. Blackman proposed overhead lights, suspended above the middle of the streets by a wire stretched between standards on either side of the thoroughfares. On the proposal of Mr. Young it was agreed to recommend the Council to place two such lights in Broad-street and two in Bridge street or Market-street. Should these give satisfaction, the system may be adopted in other thoroughfares.

Mevagissey (Cornwall).—A poll having resulted in the adoption of the Lighting Act, and as several committees had enquired into the working and cost of the several lights, and the electric had proved to be the cheapest, the Parish Council have adopted the following resolution: "Provided an electric company be formed within a reasonable time so as to admit of lighting the streets during the coming winter, this Council will offer such company the sum of £40 for lighting 30 lamps 1,500 hours in the ensuing 12 months; if any further lights be required it be paid for at the same rate. and something definite to be reported to the next monthly meeting"

Whitby.—Owing to the former contracts of the Local Board with the Whitby Gas Company being invalid, the clerk to the Urban Council said at the last meeting that it would be necessary to impose a penalty in future contracts. Mr. R. Harrowing said there was no reason why the company should squeeze them as they did, and his reason in suggesting that a penalty be inserted was to show the company that they might take some means, either by making gas of their own or by going in for the electric light, to thwart their designs. It was a shame that they should have to pay such a large sum, when larger towns—such as York—were only paying one half. He moved that the sum be £400. The motion was carried unanimously.

Plymouth.—The Corporation Tramways Committee's last minutes contained the following recommendations: "That the borough surveyor visit Bristol and Walsall, and inspect the tramway systems in those places respectively, and that he report to the committee thereupon, and as to the additional cost which would be involved in laying the Ebrington-street lines on the electrical principles adopted in the towns before mentioned." "That the tramway manager be allowed the sum of £15 for the purpose of visiting Glasgow, Birmingham, London, Liverpool, Leeds, and such other places as he may deem advisable, with a view to bringing himself in touch with the latest developments of tramway management" The minutes were adopted.

Hanley.—The Electric Lighting Sub Committee of the Town Council have recommended that the two assistant electrical engineers, Mr. Cowell and Mr. Sutherland, be appointed joint electrical engineers and managers of the electricity works under the general direction of the borough engineer, at salaries of £150 each per annum, commencing on September 1. The proposal was only to last till the extended installation was carried out The General Purposes Committee have recommended that the corporate common seal be affixed to an agreement between the Hanley Corporation and the North Staffordshire Tramways Company with respect to electric traction by means of overhead wires, and to the powers of purchase by the Corporation not being exercised for the term of 21 years. This has been approved.

Stafford.—The Electric Lighting Committee of the Town Council have instructed the engineer to have the boilers and steam-pipes, and also the steam-pipes in the engine-room covered with a non-conducting composition and to place the work with Messrs. F. Leroy and Co, of Lower Broughton, Manchester. The engineer having reported that he hoped to be able to supply the electric current for public use by September 25, the committee have appointed the chairman, vice-chairman. and Councillors Bennett, Flamank, and Wormal as a sub-committee to make all necessary arrangements in connection with the opening ceremony, and the committee asked to be empowered to spend not more than £20 on the occasion. The committee recommend that the electric cables be extended to the infirmary buildings.

Delaware Hard Fibre Company.—The following appears in the *Electrical World* New York, of August 24: "A flourishing business is reported by the Delaware Hard Fibre Company, of Wilmington, Delaware, necessitating the operation of the works day and night, notwithstanding the fact that the size of the plant has been doubled. The company has secured the contract for furnishing the General Electric Company (U S.A.) with fibre, and this work alone is sufficient to give employment to quite a large number of hands." This is supplemented by a report from Mr. Burns, to whom the company has entrusted the management of its business in all parts of the world except the North American Continent, who states that the progress of business during 1895 shows a gratifying and unexpected increase over 1894.

Rugeley.—Mr. Gilbert, at the Urban Council meeting, submitted a statement on behalf of the Lighting Committee, explaining that the gas company were willing to grant a reduction of 1s. per lamp on all the small lamps. and the committee recommended the acceptance of this offer for the coming season only. They asked the Council for power to take into consideration the question of lighting the streets by electricity, as they had already received two tenders from leading electrical firms which compared very favourably with the cost of lighting by gas, and several applications from electrical engineers asking to be allowed to submit schemes. The committee felt that it was too late to do anything in the matter this season, but if their recommendation was adopted they suggested that it might be taken up next year. The report was carried.

Carnarvon—The National Telephone Company have written to the Harbour Trust stating that if sufficient encouragement were given they proposed to open up Carnarvon and Bangor for telephonic communication by establishing telephone exchanges in each town, and connecting the offices or residences of subscribers thereto. When these exchanges were opened the company saw no reason to doubt that the Government (Post Office Department) would continue the trunk lines through from Llandudno, and so enable subscribers to have telephonic communication throughout their system It was suggested that such a communication would prove of great advantage to the harbour. Mr. Lloyd Carter moved, and Mr. C. A. Jones seconded, that the Trust should sign an agreement for one year with the telephone company. After some discussion as to the scale of charges, which was considered excessive, the proposal was unanimously agreed to.

Cheltenham.—Mr. Norman, in introducing the minutes of the Public Lighting Committee, has mentioned that the gas lights had shown a tendency to fall below the standard of 17 candles. With regard to the electric light, the month had been one of unbroken success. Having referred to the proposed purchase of transformers and other minor matters, he passed on to consider the question of lighting the principal streets, and also favoured a memorial sent in by Mr. Selim Smith that the new light should be taken up above Cambray. He believed that a striking effect would result from arc lamps amongst the foliage in the Promenade. Mr. Norman then entered at some length into the question of cost, of which he took a hopeful view. Mr. Margrett moved an amendment to the effect that the electric light should not stop at the Royal Hotel, but should be carried up to the Belle Vue Hotel. This was seconded by Mr. Dimmer, and accepted by the committee.

Kirkby Lonsdale.—The Chairman said, at the last Urban Council meeting, that he had had some talk with representatives of the National Telephone Company at Kendal respecting the inclusion of Kirkby Lonsdale in the district. He asked the secretary to write down his suggestions, with remarks as to the advantages, cost, etc This communication he had received, and sent to some of the leading tradesmen of the town to get their advice, and to see whether the service would be of utility to the town and district. The chairman said the annual subscription was about £8. This would ensure free telephonic communication to all towns within the district, including Kendal, Windermere, and the intermediate places. Outside the district there would be trunk lines, and towns such as Lancaster would be 3d. extra, Preston 6d., etc. It was necessary to have 10 subscribers before an exchange could be opened. He hoped the tradesmen in the town would consider the matter, and some of the local gentry might become subscribers as well.

Hastings.—The Roads Committee of the Town Council have received from the secretary of the Hastings and St. Leonards Electric Light Company, Limited, notice of the intention of the company to extend their main from a point opposite the junction of South-terrace with Queen's-road, across the road to the box opposite 36, Queen's-road, thence to 57, Queen's road, a distance of 170 yards. A high-tension cable was intended to be carried in 2¼in. wrought-iron pipes, with socket joints, and a low-tension cable in 2¾in. wrought-iron pipes. Both pipes were to be laid under the pavement about 2ft. from the kerb, at a depth of 2ft. A cast-iron box, marked "b" on the plan, was to be laid in 4½in. brickwork, the size of the same being 2ft. by 18in., pavement frames and covers being provided in connection with the same. The committee recommended that the plan be approved, subject to the works being carried out to the satisfaction of the borough engineer, and to the company undertaking not to remove the cover of the box, except between the hours of 10 p.m and 9 a.m., unless in case of actual emergency. The report was adopted.

New Malden (Surrey).—With reference to the communication from the Kingston Corporation as to supplying electric current to Coombe, the Clerk said, at the last District Council meeting, that he had not yet had time to prepare a report as to the future legal position of the Council in regard to the matter. The matter would therefore have to stand over for another month. Mr. Monro said Mr. Willis was engaged in altering his house, and desired to have an electric installation at the same time. It was a pity there would have to be another month's delay. Mr. Willis would like to have the permission of the Council to have the installation as soon as possible. He (Mr. Monro) did not think the Council ought to stand in the way of the spread of the electric light in this district. It was usual in cases where an outside authority wished to supply the current for the local authority to stipulate that it should be allowed to take over such part of the plant as lay in its own district at any time it pleased and at cost price (or less), without any allowance for goodwill or for the fact that the plant was part of a going concern. The discussion was adjourned until the next meeting.

Romford.—Mr. Westgate having given notice to move that the Urban District Council should take such steps as are necessary to obtain the powers to use the electric light for the parish, Mr.

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Smith suggested that the consideration of the matter should be deferred to the next meeting. The Chairman did not wish to enter into any discussion as to the merits of the proposal, although he differed somewhat from the opinion of the proposer. He thought that if they went to the Board of Trade for a provisional order, to exclude any other company, they would not get it. If any authority came forward and asked permission to establish works simply with the object of excluding any other company, it was a policy which he thought the Board of Trade would not approve of. It would be a selfish policy unless they could show a *bonâ fide* intention to carry out the work in one or two years. Mr. Westgate thought it possible that they might get the work carried out within two years. The cost of obtaining the provisional order would not exceed £100. Mr. Smith: I have never known one cost so little. Mr. Westgate: I have not watched the question. Mr. Smith: I have, and I have known them to cost £600.

Kendal.—The surveyor to the Westmorland County Council has reported that the National Telephone Company have applied to build a line from Kendal to Ambleside, to pass through Burnside and along Winter-lane, and to come on to the main road from Kendal to Ambleside about half a mile south of the Staveley level crossing over the railway. In the length to the junction with Over Staveley, at Gawen Bridge, rather short of one mile, they would erect 29 poles. In the village of Staveley the surveyor could not see that it would be advisable to allow any poles to be erected, but, after leaving the village, he saw no objection either in this township or Hugill to erect about 68 poles. The line would then pass through the Windermere urban district as far as Troutbeck Bridge, and continue through Troutbeck to Holbeck Bridge. There would be difficulty here, as it would not be wise to allow the poles to be placed on the west side of the road, as the parapet is quite narrow enough, but if the company could arrange their poles on the east side he could see no objection. There should be no interference with the traffic, and a charge of one shilling per pole per annum should be paid. The committee have resolved that the National Telephone Company be allowed to erect poles on the main road, as set out in the report, to be placed under the direction of the county surveyor.

Halifax.—The Town Council are considering various proposals for tramways with a view to coming to a decision as to the system of traction to be adopted, and also whether the lines shall be worked by private companies or by the town. We understand that the Corporation intend placing six arc lamps, each with a power of 1,500 candles, between Old Market and Cow green, the intervening route being Crown and Silver streets. These illuminants will hang from the curved top of ornamental iron standards, reared several feet higher than the ordinary street lamp. Messrs. Macfarlane, of Glasgow, are supplying these; one is now in position at the Commercial Bank corner. Other of the main streets are to be so lighted in turn. The Yorkshire Penny Bank is the most notable recent connection with the electricity mains. In pursuance of the Corporation's decision, these mains are being extended along Skircoat-road towards Heath, in which district rather an extensive application has been made for the light. At the electricity works, at the bottom of Foundry-street the foundations are being prepared to receive the new combined engine and dynamo, of 600 h.p., which Messrs Pollit and Wigzell, of Sowerby Bridge, are making, and hope to have ready next month. The new infirmary is to be lighted by electricity from a plant to be laid on the premises.

Alsager (Stoke-on-Trent).—A meeting of ratepayers has been held to consider the advisability of adopting some system of street-lighting. The circular issued by the District Council convening the meeting laid the cost of gas and electric lighting before the ratepayers and showed that the former would cost £142 per annum, or an increase in the rates of 3½d. in the £. These figures were obtained from estimates provided by the Kidsgrove Gas Company, which has mains laid in Alsager for private supply. A scheme of electric lighting prepared for the Council by Mr G. R Peers, A.I.E.E., placed the cost of an installation for 1,200 lamps of 8 c.p. alight at one time at £4,000, including 40 street lamps. The annual cost of maintenance would be £618, while the revenue expected from 1,500 lights fixed would be £700, leaving a profit of £82, or no increase in the rates. The gas company was well represented at the meeting, and during the week two circulars had been issued trying to show that electric lighting was a very risky venture. The meeting decided that the streets should be lighted, and Mr. Richmond (a councillor, and interested in the gas company) addressed those present. When the *pros* and *cons.* of gas-lighting had been exhausted, Mr. Peers was called upon to address the meeting and was asked several questions relating to electric lighting which he satisfactorily answered. Eventually the meeting was adjourned for 12 months.

Sheffield.—At the meeting of the Parliamentary Committee of the City Council the following letter from the Sheffield Tramways Company to the town clerk was read and ordered to be entered on the minutes: "Dear Sir,—My directors desire again to communicate with your Corporation upon the subject of the company's lease of the tramways, which, I may remind you, will expire in July next year, and I am to state that they are willing to negotiate terms for a renewal of the lease, and, if terms are not agreed, I may add that the company will be prepared, in the words of the 47 Section of the Sheffield Tramways Act (1872) upon reasonable terms to the satisfaction of the Board of Trade, to continue to work the tramways." The committee resolved: "That this committee are not prepared at present to report whether or not it is desirable that the Corporation should take over and work the tramway system of the city at the expiration of the leases granted to the Sheffield Tramways Company, but they advise the Council that to enable the Corporation to work the tramways power would have to be obtained by an alteration in the existing Act of Parliament, and that such power would have to be obtained by a Bill in the next session of Parliament, and they also advise that steps should be taken to obtain such power." Certain information obtained by the city surveyor and the city accountant with regard to the result of the working of certain tramways under the management of corporations was laid before the committee, and the consideration thereof adjourned to the next meeting, to be held on Tuesday, October 1 next.

Cheadle (Staffs.).—A special meeting of the Parish Council has been held to discuss the most effective and economical mode of lighting the public streets. The Cheadle Gas Company have hitherto held the contract but the Council took exception to last winter's supply, and in accordance with the Local Government Act of 1894 advertised for tenders. The gas company's tender was to light 60 lamps for the 10 months' period at a charge of £3 per lamp, guaranteeing a light of 16 c. p. in each burner. Mr. Ralph Alcock (Cheadle) was prepared to meet the Council's requirements by the aid of paraffin oil lamps. His tender for a term of seven years would be at the rate of £168 per annum or for one year alone £150. There were several other tenders sent in, but the offer which most impressed the Council was one from Messrs. J. and N. Phillips and Co to light the town by electricity. The firm has a large tape manufactory in the town, and could supply the street lamps from the plant to be used in connection with their own lighting. They were in a position to lay down the necessary fittings and light the town for a period of seven years, at an annual cost of £340. If the contract were extended to 14 years the yearly cost would be reduced to £300 The Council, having carefully considered the tenders, were unanimously agreed that the electric light would be the most satisfactory method of illumination, but they could not lose sight of the fact that to accept Messrs. Phillips's tender would be to slightly increase the lighting rate. It was considered desirable to test the feeling of the ratepayers on the subject, and it was therefore resolved that a parish meeting be convened to see whether the Council should accept Messrs Phillips's tender or otherwise.

Hammersmith.—The Electric Lighting Committee reported, at the last Vestry meeting, that they were called together in consequence of a communication from the chairman of the Governors of the Latymer Foundations, he having received a letter from Messrs. Rollitt and Sons offering, on behalf of a client, the sum of £2,100 for the portion of the land in Fulham Palace-road belonging to the Foundation, for which the Vestry are in treaty for the purposes of the electric lighting order. They very carefully considered the matter and under the circumstances they had, subject to the ratification of the Vestry, offered £2,200 for the land The clerk said that 14 tenders had been received for schemes for the electric installation for public and private lighting. He had also received a telegram from a Glasgow firm stating that their tender would arrive on the following day, and they hoped it would not be too late Mr. Glasier proposed that the tenders already sent in should be initialled, and that the one they had received notice of by telegram should be considered along with the others by the Electric Lighting Committee Mr. Payne seconded. The committee's action was agreed to. The Clerk read a circular letter from the City of London Electric Lighting Company, referring to a recent case in the Court of Appeal, stating that it was intended to convene a meeting to determine upon a course of action with the object of obtaining an amendment of the law that will give reasonable protection to undertakers, and at the same time to secure full compensation to all persons and bodies interested, for all damage caused by the user of any electric light works and they were advised that this object would be attained were a general Act of Parliament passed containing a clause in the form annexed to their letter. A letter had been received from Mr. W. H Trenthand, dated 30th ult, offering his services to advise the Vestry in connection with the electric lighting scheme.

Oxford.—The Lighting Committee reported at the last meeting of the City Council that they were in negotiation with the Oxford Electric Company for a revised and extended system of lighting by electricity, and in order to complete these negotiations they recommended that (if necessary) the existing contract with the company be extended to March 25 next. Mr. C. Underhill stated that the committee had rejected the proposals that had been made by the electric light people, who, he believed, wished to light several fresh streets and to increase the power of the present lights. He maintained that the incandescent gas lighting was not satisfactory for the public streets, and he did not see why the Corporation should pay a single penny for the experiment which the gas company wished to carry out. The committee had no right to reject the proposals of the electric company without coming to the Council, and he would move that the report be referred back, to bring up an amended report setting forth the merits of the two proposals—the electric company and the gas company. Alderman Wilson said he understood that the idea was to give the gas company the same power to furnish the public with an object-lesson of what they could do to compare with the great experiment for which the public had paid a considerable sum to enable the electric light company three years ago to do the same. The electric light company carried out that experiment, and he thought the gas company should carry out theirs. Mr. Brooks said the proposals of the electric lighting company were such as the committee thought they might accept, and the request to extend the contract until next March was to enable them to complete the arrangements. The Town Clerk said the present contract would expire on November 16, and the committee hoped

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to be able to report before next March. There had been no rejection of proposals from the electric company, but the experiment in Beaumont-street, he believed, had been begun. The report was adopted.

Tunbridge Wells.—A correspondent writes: "Councillors have met and transacted municipal business under difficulties in a sub-tropical atmosphere. The gas ventilators were lighted, but the remedy proved worse than the evil, and the gas was speedily extinguished. The suggestion that the electric light would render the atmosphere of the Great Hall more endurable instantly brought the three gas shareholders on the Council to their feet, but this was only the prelude to the most striking illustration which the gas representatives have yet afforded of their dual capacity. It was the meeting at which the half-yearly rate is made, and the chairman of the Finance Committee, who is also the chairman of the gas company, adopted an unparalleled course in his latest attack on the electric light. Mr. Delves, without the support of a single one of his colleagues, moved an amendment to his committee's report with a view to putting a penny more on the general district rate than the committee considered necessary, inasmuch as the estimates showed that the Council would just tide over the half-year without further burdening the ratepayers. A gentle titter went round the council table as Mr. Delves once more attacked the electric light, which with him occupies the unfortunate position of King Charles's head in Mr. Dick's memorial, and amidst growing impatience Mr. Delves persisted in his single-handed attempt to add an unnecessary penny to the rates, in spite of taunts interjected by his colleagues of his gas interests and humorous references to his past financial predictions, which have also been ludicrously wide of the mark. At first no one seconded Mr. Delves's amendment, and then Mr. Finch did so for the sake of discussion, but declined to vote for it. Not only Mr. Delves's colleagues on his own committee, but the officials, in reply to questions by members, flatly contradicted most of his statements, and the anti-climax was reached when a division was taken, and only the three gas shareholders present voted in the affirmative. Who, by the way, is the member of the Council, more than once alluded to during the sitting, who has been canvassing consumers of electric energy and endeavouring to frighten them into the belief that the current which the Corporation supply is more expensive than the rival commodity of gas, in which he deals?"

Blackburn.—An important suggestion has come before the Gas Committee of the Town Council in the shape of a letter from the secretary of the Blackburn Corporation Tramways Company, Limited, stating that the company had been considering the question of working the Preston New-road and Cemetery sections of the tramways with electric traction, and that Mr. E M. Lacey had prepared a report on the matter, from which it appeared the tramways could be worked cheaper by this method; also stating that the company had not the necessary capital to carry out the scheme, and asking if the Corporation would consider the question of providing the necessary capital, and if so, upon what terms. This matter is now in the hands of a sub-committee. The committee also considered the report of the borough electrical engineer upon the proposed extension of the electric lighting installation to Preston New-road and district, on the high-tension alternating system, together with estimate of capital cost and annual income. It was resolved that the proposed extension be carried out, that it be referred to the sub-committee to have specifications prepared for the plant required, together with estimates, and for that purpose to consult Mr. E. M. Lacey, A.M.I C.E, to obtain tenders and submit the same to a future meeting of the Electric Lighting Committee. Councillor Garsden, in respect of the tenders received for wiring and fittings required for the electric lighting of the Town Hall, asked why it was that, a committee having decided that no tender above a certain sum should be entertained, the sender of one tender above that sum had been asked (with others) to furnish designs for fittings. Councillor J. Law stated that among the tenders was one from a very respectable firm of local tradesmen which was only two or three pounds above the sum specified as the maximum, and he had, after consultation with other members of the committee, taken the liberty of including these local tradesmen. Councillor Garsden moved that the minute be referred back. The Mayor said the committee's original decision was that no tenders above £900 should be considered. The one in question, he believed, was £908 and there was so strong an opinion that local tradesmen should be allowed to compete that this tender was included. Councillor Garsden's motion was lost, and the minutes were agreed to.

Chelsea.—The annual report of the surveyor to the Vestry, Mr. T. W. E. Higgens, contains the following: The number of houses in Chelsea lighted by electricity for the last three years was as follows:

	1892-3.	1893-4.	1894-5.
Chelsea Electricity Supply Company ...	390	500	598
London Electric Supply Corporation ...	—	6	9 (?)

Extension of Mains: The Chelsea Electricity Supply Company have made various applications to extend their mains throughout the area east of Beaufort-street, and they are making steady progress with the lighting of the better-class property in Chelsea. The London Electric Supply Corporation made an application to extend their mains through Cadogan-gardens, Draycott-place, Smith-street, Tedworth-square, Cheyne-walk, and the Embankment, and I recommended the Vestry to ask the Board of Trade to compel the company to establish converting stations if they carried out any large extensions, so as not to supply at high pressure. *Street lighting*: In January the Chelsea Electricity Company made an offer to light certain streets by means of arc lights, but the Vestry were unable to accept the offer. *Pressure Records*: I have examined the pressure records of the Chelsea Electricity Company from time to time, and find that they still maintain a very good average. A voltmeter connected to their mains has been fixed in my office, and it usually stands quite steady, slightly above 100 volts. When the London Electric Supply Corporation made application to extend their mains I reported to the Vestry that the record kept at Adelphi-terrace was useless as a record of pressure in the Chelsea circuit. This led to some correspondence with the Board of Trade and the company, but the only result was to strengthen my conviction, and consequently I have not examined the company's pressure records since the matter was reported to the Board of Trade. *Meter Testing:* Only one application was made during the year to have a meter tested, which was from 46, Elm-park-gardens. Mr. Morgan Williams, A.M.I.C.E., tested it on behalf of the Vestry, and it was found to be registering 1·3 per cent. under at full load, to be correct at half load, and 15 per cent. over at a light load. As the load was very light at these premises a smaller meter was inserted by the company, and the cost of the test was paid by them. *Town Hall Lighting:* Messrs. B. Verity and Son wired and fitted up the Town Hall for electric lighting. Up to the present time the difference in cost as compared with gas is inappreciable.

Canterbury.—The Electric Lighting and Street Lighting Committees of the Town Council have reported: "The surveyor, as instructed by the Electric Light Committee at a former meeting, reported as to the information he had obtained from numerous towns and districts with reference to the electric lighting in use at such places, and after careful consideration the committee are of opinion that the time has arrived for the introduction of the electric light to the city, but that before any scheme is adopted, or works undertaken, recommend that the services of Mr. Robert Hammond, M I E E, London, be retained for the purpose of advising the Council and preparing an exhaustive report upon the whole subject, at a fee not exceeding 50 guineas, to merge in the usual engineering commission in the event of a scheme being adopted and works carried out." The Mayor proposed, and Councillor Lukey seconded the confirmation of the minutes. Councillor Harris thought the matter needed further consideration. The Brush Company evidently thought the undertaking would be a failure as an enterprise, otherwise why had they withdrawn from the proposal? When Mr Garcke went into the matter, in the time of the late Mr. Prentice, the city was being lighted with gas for £1,600 or £1,700 a year. But the figures of the Brush Company brought the estimated cost up to £2,700 and then it was found that the city could not be wholly lighted with electricity. The company would not take over the order unless the Corporation guaranteed so many lights or so much money per year. The Council had never yet received a fair and honest report as to why the Brush Company dropped the matter. Alderman Mason said it was no fault of the Corporation that they did not succeed in making terms with the Brush Company. They imposed conditions it was almost impossible to accept, and the Council were only too glad to get rid of the company, who would have tied them for 21 or 42 years. The committee might now be able to light the city at a profit—he was told that if a sufficient number of private consumers could be found they might have the public lighting at a nominal figure. They would, however, always have to depend upon gas for the lighting of some portions of the city. The committee now simply asked the Council to confirm their proposition that Mr. Hammond be asked to prepare a report on the matter. If the Council then wished to have none of it they could vote against adopting his plans. He thought this £50 would be well spent in obtaining the advice. An amendment in favour of the report being referred back for further consideration was lost, and the report adopted by five votes to one.

Glasgow. — The Special Committee on Telephone Service reported, at the meeting of the Town Council, that they had resolved to renew to the present Postmaster-General the application which the Corporation made in August, 1893, to his predecessor in office for a license empowering them to establish a telephone exchange service within the city The committee also resolve to intimate to the London County Council the making of this renewed application, and to thank that Council for the assistance they had already given to the Corporation in connection with the last application. Bailie Alexander explained that a fresh application had been rendered necessary by the change of Government. The minute was confirmed. The minutes of the Tramways Committee stated that it had been remitted to a sub committee to further consider the question of mechanical motors, and to report. Treasurer Gray objected to the appointment of this committee. It was just two years ago since the Council were assured by Mr. Paton that the committee had gone into the whole question of mechanical motors, and had found that they must revert to horse haulage They found that the overhead electric system cost £10 000 per mile double track, that the cable system cost £20 000, and they recommended that these systems should not be adopted. They had deliberately spent £400,000 on the horse-haulage system, and within a little more than a year, before a single penny had been returned to the committee, it was proposed to consider a new system. He held that there should be no foreshadowing of additional expense until the present system had been tried for another year or two. He wished his dissent entered against this proposal. Mr. J. W. Dick was surprised at the proposal now made The question of mechanical motors was considered for three years, and as a result the Council had at the time been brought face to face with the fact that nothing but horse haulage could be adopted. Their various establishments

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had been constructed with a view to horse haulage. Before he could agree to the proposal it would require to be shown to him that something new had been learned with regard to mechanical motors. He moved that the minute be not approved. Treasurer Gray seconded. Mr. Walter Paton said that Treasurer Gray had completely misrepresented what he said regarding horse haulage at the outset of the tramway undertaking. What he said was that from the very nature of the case the Corporation were bound to commence with horse haulage. They had had a year's experience of it and had learned a good deal during that time. It was his opinion, and also the opinion of a good many members of the committee, that the time had now come when the question of mechanical motors should be fairly considered as applicable to some sections of the line. The minutes were approved by a large majority.

Bangor (Wales).—A special meeting of the Bangor City Council has been held to receive and discuss the following report of the Electric Lighting Committee: "The committee reconsidered Mr. Medhurst's report and the resolution of the committee of July 24, and after a long discussion it was proposed by Mr. Richard Davies, seconded by Mr. T. G. Williams, and resolved *nem. con.* that this committee adhere to the resolution passed on July 24 namely, 'that this committee having carefully considered the question of lighting the borough with the electric light, and called to their aid Mr. Medhurst, recommend the Council to apply for a license with the least possible delay, and that the committee be empowered to take whatever steps may be necessary to carry out the scheme as suggested by Mr. Medhurst in his report.'" With regard to the question of a site for the proposed electric light works, the committee reported that "Colonel the Hon. W. E Sackville West wrote stating that Lord Penrhyn was willing to sell the freehold of the field near the police station for the sum of £400, the consent of the Bishop to be obtained before any buildings were erected on the land. It was proposed by Mr. Robert Hughes, seconded by Mr. Robert Owen, and resolved, that the Council be recommended to accept Lord Penrhyn's offer, providing the Council adopt the resolution to apply for a license under the Electric Lighting Acts." Dr. Grey Edwards, in the absence of Mr. T. C. Lewis, the chairman of the committee, moved the adoption of the report. Supposing, he said, that they put down an installation as suggested, costing £13,000 to provide for 4,000 lights, the profit would be something like £100 or £150. If they increased the number of lights to 6,000, they would only have to increase their capital by £3 000. Charged at the rate of 10s. per light, these extra lights ought to bring them in £1,000 a year, so that, if they increased the number of lights, the profit to the town would be enormous, and would very much aid the Council in reducing the rates. He did not think 6,000 lights would be too many for Bangor. The 4,000 lights would be equivalent to 10,000,000 cubic feet of gas. Very large buildings were about to be erected in Bangor—the new Friars School, the intermediate school for girls, the new college hall for women students, all of which would probably take the electric light. Mr. Medhurst said that if the Council obtained a provisional order and did not take it up at once it would be rescinded, and any applying company could obtain what they asked for. He explained the way in which the electric light was being worked in several large towns Referring to an opinion expressed by Mr. Newbigging, he said that the latter, at a meeting of the Institute of Gas Engineers held at Edinburgh, stated that the gas industry had nothing whatever to fear from the electric light industry, and that the tendency was to increase the consumption of gas where electric plant had been laid down In no instance to-day was there a local authority that had supplied its own electric light which had not made a net profit in the third year of working at the latest. To-day, it was very difficult for a company to obtain the necessary legal rights, because local authorities saw that the electric light industry was profitable and they would therefore not allow any company to form a monopoly of it, as unfortunately they had in many cases done with gas and water. A canvass was usually made in towns taking up the electric light to ascertain how it would be received by the inhabitants, but that would be after the decision had been arrived at to adopt the scheme. The committee's report, with their resolution, as amended by Dr. Grey Edwards, was then carried.

Kingston-on-Thames.—The Lighting Committee of the Corporation have just issued a circular calling attention to the fact that on and after January 1 next they will make a reduction in the price of the electric light in the form of a rebate to those consumers whose use of the light exceeds two hours per day on the average throughout the year. The committee state: "The new tariff will be as follows: The present price of 6d. per Board of Trade unit will be charged until the customer has consumed sufficient electricity to average a daily use for two hours of the number of lamps he has had burning simultaneously, and all electricity consumed after that time will be charged at one-third less—viz, 4d. per unit. In carrying out this system of reductions the committee will not require the consumer to use sufficient electricity to equal two hours' daily use of every lamp fitted, the two-hour rate (6d. per unit) being charged only on the number of lamps used simultaneously, consequently those customers who have many lamps in different parts of a building and used at different times will largely benefit. An instrument will be fixed on the consumer's premises that will correctly indicate the proportion of the electricity to be charged at 6d. and 4d. per unit respectively. You will notice that this scheme benefits the small consumer equally with the large consumer. The greatest benefits are obtained under this sliding scale by regular and lengthy use of the light; therefore, those consumers who instal lamps in such places as sitting-rooms, kitchens, basements, etc., will experience the largest reductions, and when the light is used the length of time customary in such places, electricity will be found to be not only the healthiest, cleanest, and safest, but also the cheapest illuminant. As the reduction is based on the lengthened use of the number of lamps each consumer burns simultaneously, and not on the total number he has installed, it is to his own interest to instal lamps wherever he requires light, as by this means he can prolong such use of the light. The committee are making this very liberal reduction in order to encourage their consumers to use electricity more generally both for lighting, cooking, heating, and motor purposes, and to induce shopkeepers to instal the light in the residential part of their premises, and private consumers to instal lights throughout their houses instead of in one or two rooms only. The consumers' gain under the new tariff will be shown at a glance from the following accounts: old tariff for one year, 365 units at 6d., £9. 2s. 6d ; new tariff 182½ units at 6d., £4. 11s 3d.; 182½ units at 4d., £3 0s 10d ; for one year, 365 units, £7. 12s. 1d ; thus saving £1. 10s. 5d. per annum. Consumers with larger installations using their lamps in a similar manner will of course obtain the benefit of a like proportionate reduction. Under the new tariff hotels, public-houses, and all buildings where artificial light is used for a lengthy period will benefit largely. Consumers deciding to adopt the demand indicator system of rebate will of course accept it in substitution for any other mode of discount or reduction otherwise allowed. The Lighting Committee would take this opportunity of again pointing out to the householders in the borough that they are all directly interested in the success of the electric lighting undertaking of the Corporation, and that benefit to the ratepayers from the successful financial working of the central station can only be brought about by a considerable increase in the demand for electricity, and the committee feel sure that if in his own interest every ratepayer will well consider this question he will see the advisability of becoming a consumer of electricity supplied from the works, in which as a ratepayer he is a shareholder. There is no doubt that electricity as an artificial light is unrivalled, whether installed in private or business premises. Upon application a demand indicator will be fixed on the consumer's premises at the Corporation's expense, for which a rental of 1s. per quarter will be charged."

Lambeth.—The Lambeth Vestry have considered another phase of the electric lighting question. Some time since the Brush Electric Lighting Company wrote offering to take over from the Vestry the electric lighting order, and had since given notice of their intention to apply in December next for the transference of the order from the Vestry to themselves. A similar intimation had been received from the Capital and Counties Electricity Company. The Lighting Committee (supplemented by the addition of two representatives from each of the standing committees) now report having considered these communications, and resolved to recommend the Vestry to write to the two companies "intimating that the Vestry have no intention of proceeding at present under the provisional order granted to them" Mr. Nash, at the last meeting, moved the adoption of the report. Mr. Everett moved, as an amendment, "that all words after 'vestry' in the recommendation be deleted, and the following substituted: 'while not in possession of sufficient information to justify an immediate proceeding under the provisional order obtained, has no intention of surrendering the order.'" Mr. Everett remarked that although he was not in favour of immediately going on with the electric lighting scheme, yet he could not agree with the proposal that they should virtually surrender the order. He apprehended that the Vestry would agree with him in saying that if they adopted the recommendation the companies would take their decision to the Board of Trade, and probably that Board, acting upon its tenour, would revoke the order. At the same time he was bound to say that since the question was previously discussed many of them had carefully been on the look-out for information as to the experience of other parishes Whitechapel, he understood, was in a similar predicament to Lambeth, and the Vestry of that parish had passed a resolution in similar terms to that which he now proposed. He pointed out that there could be no harm in waiting for a short time. They had, for instance, recently been informed that the London County Council lent money for electric lighting purposes at 2¾ per cent., as against 3½ per cent. previously. That in itself would mean a great difference in the ultimate cost; indeed, in St Pancras the margin between the higher and lower rate of interest would almost cover the cost of generating for one year. Looking at the more recently available information, he thought the Vestry would be unwise in allowing a private company to come in and make a monopoly of the electric light. He regarded it as the Vestry's duty to keep the companies out of the parish; and even if the Vestry waited before they took the scheme in hand, they would gain through the daily diminution in the price of electrical apparatus. Mr W. J Hosking seconded, pointing out that the whole point now before them was whether they would unconditionally surrender the order or seek further time to consider the question. Many things had, as Mr Everett said, changed in connection with electric lighting—the interest on loans had become lower, and the price of electrical apparatus was daily decreasing. At the same time, while he agreed that there should be delay for the present, he could not consent to the arguments of some that they should wait until the electric lighting system had become perfect. It was through taking up that position that their forefathers gave the gas monopoly to private companies; and had the pioneers of railways been influenced by similar considerations, they would never have advanced beyond the primitive locomotive of George Stephenson. Alder-

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man Hubbard said that the opponents of the scheme had industriously assured the parish that Mr. Preece's scheme proposed an outlay of £300,000, and compared the expenditure to throwing that amount of money in the street As a fact, Mr. Preece recommended the spending of £75,000 as an initial outlay, and this would take four years to spend; so that if the scheme proved abortive, £75,000 would be the amount lost, and not £300,000, as had been represented. Moreover, he (Mr. Hubbard) had very good evidence that Mr. Preece was too liberal in his estimate—that £40,000 would be nearer the initial outlay and that that amount would provide a valuable asset for Lambeth. He quoted the experience of Leeds and Liverpool to show that when a company had been once let in the municipal authority could not acquire the monopoly except on payment of a large premium. St. Pancras, too, furnished them with a capital object-lesson. Mr. Bennetts said there could be no doubt that the municipalisation of electricity was proving a success. The parish of Islington was about to commence operations, Shoreditch was opening out its works, and the little parish of Ealing was also about to start the electric light. He suggested that the committee should be appointed to investigate the whole matter, in order that when December came they might have something definite to lay before the Board of Trade. Mr. Ogilvie warned the committee that they were placing too much reliance upon the report of Mr. Preece, who was the alpha and omega of their scheme He looked upon the report of Mr. Preece as distinctly the report of an enthusiast. He (Mr. Ogilvie) would like to see the electric light available to Lambeth, but he certainly did not think himself justified in giving the parish a luxury out of the rates. He thought they should have a special night for the discussion of the subject On a show of hands the amendment was adopted without dissent, and the report as amended was adopted.

PROVISIONAL PATENTS, 1895

SEPTEMBER 2.

16427. **Improvements in electric bell pushes.** Eduoard Percy Cranwill Girouard, 47, Lincoln's-inn-fields, London.

SEPTEMBER 3.

16439. **Improvement in dynamo-electric machines.** Frederick Henry Royce, Eastbourne, Holland-road, Chorlton-cum-Hardy. (Complete specification.)

16450. **Improvements in stage or like arc lamps for alternating currents.** Alfred Sykes, Market-place, Huddersfield.

16482. **Improvements in electric and pneumatic bell pushes.** Harry George Warner, 23 Coleman-street, London.

16494 **Improvements in or relating to supports for overhead electric conductors.** William Robert Lake, 45, Southampton buildings, Chancery lane, London. (Charles Jordan Goodwin, United States.)

16521. **Improvements in and connected with the overhead system of electric traction.** Walter Charles Bersey, 53, Chancery-lane, London.

SEPTEMBER 4.

16557. **Electro-deposition of gold and silver.** Emile Andreoli, 18, Somerleyton-road, Brixton, London. (Complete specification)

16562. **Improvements in multiple electrical switches.** Hugo Hirst, 73, Stephen's-road, Upton Park, London.

16569. **Improvements in the manufacture of electrodes for voltaic batteries.** Ludwig Epstein, 28, Southampton-buildings, Chancery-lane, London

16582. **Improvements in storage battery plate.** Fred Newell Tilton, 40, Chancery-lane, London

SEPTEMBER 5.

16635. **Improvements in the regulation and construction of electric motors.** William Law Pakenham and John Charles Howell, 55, Chancery-lane, London.

16651. **Improvements in electric glow lamps.** Ernst Rosenberg, of the firm of H. M. Salmony and Co., 45, Southampton-buildings, Chancery-lane, London. (The firm of Von Severen and Schwabe, Germany.)

16659. **Improvements in and relating to electric railways.** Reginald Belfield, 31, High Holborn London. (The Foreign Electric Traction Company, ——.)

SEPTEMBER 6.

11728A. **An improvement in voltaic batteries** William Shaw, 70, Wellington-street, Glasgow. (Date claimed under Patents Rule 19, June 17, 1895) (Complete specification.)

16700 **Apparatus for supplying electrical energy to tramcars from underground conductors.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany)

16701. **Contact apparatus and appliances in connection therewith for facilitating the passing of tramcars over crossings and switches in electrical tramways with underground conductors.** Siemens Bros. and Co, Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.)

16702. **An element for secondary voltaic batteries.** Prosper Vandersmissen, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16736. **Improvements in or connected with apparatus for extracting gold and silver from cyanide solutions by electricity.** Johannes Pfleger, 47, Lincoln's-inn-fields, London.

16737. **Improvements in or connected with electrical apparatus for extracting gold and silver from cyanide solutions.** Johannes Pfleger, 47, Lincoln's-inn-fields, London.

SEPTEMBER 7.

16742. **Reversible rotary incandescent electric light switch.** John William Fielding, 59, Dairyhouse-road, Derby.

16794. **Improvements in and relating to the calibration of electric measuring instruments.** Sydney Evershed, 1, Queen Victoria-street, London.

16796 **Improvements in electromagnets.** Illius Augustus Timmis, 2, Great George-street, Westminster.

SPECIFICATIONS PUBLISHED.

1894.

15575. **Gasoliers, electroliers, etc.** Smith.

15774. **Electric cables.** Saunders. (Greey and another.)

16105. **Electrical deposition of zinc, etc.** Heathfield and Rawson.

17529 **Telephone receivers, transmitters, etc.** Higgins.

18274 **Arc lamps** Brockie.

18274A **Arc lamps.** Brockie.

19444. **Arc lamps.** Stout.

19807 **Electric door contact.** Oppenheimer.

20043 **Arc lamps.** Geipel.

22043. **Electrically heating metals.** Holland.

1895.

4939. **Electrolysis.** Andreoli. (Second edition.)

13388 **Arc lamps.** Devonshire (Thomson and another.)

13389. **Regulating speed of continuous-current motors.** Devonshire. (Wightman.)

13404. **Dynamo-electric machinery.** Royce and Claremont.

13550. **Dynamo-electric machinery.** Royce and Claremont

13564. **Electric regulators.** Bonsor.

13638. **Incandescent lamp mantles.** Crocker.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5⅝
Brush Company, Ordinary	3	1⅛-1¼
—— Nom. Cum., 6 per cent. Pref.	2	1⅞-2⅛
—— 4½ per cent. Debenture Stock	100	111-114
Charing Cross and Strand	5	5½-5⅝
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6¾-7¼
City of London, Ordinary	10	15-15½
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	133-137
City and South London Railway, Consolidated Ordinary	100	38-40
—— 4 per cent. Debenture Stock	100	134-136
—— 5 per cent. Pref. Shares	10	14½-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1-2
—— 5 per cent. First Mortgage Debentures—1-400 of £100 and A 1-200 of £50	100	—
Electric Construction, Limited	2	⅛-¼
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	2⅛-2¼
Electricity Supply Company for Spain	5	—
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	1-1⅛
Fowler-Waring Cables	5	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	11½-12½
—— 7 per cent. Preference	10	15-16
—— 4½ per cent. Debentures	100	104-107
House-to-House Company, Ordinary	5	3½-4
—— 7 per cent. Preference	5	7⅛-7½
India Rubber and Gutta Percha Works	10	19-21
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅜-8⅛
—— Pref.	—	—
Liverpool Overhead Railway	10	11½-11⅝
—— 5 per cent. Pref.	10	15-15½
—— 4 per cent. Mortgage Debentures of £100	100	111-113
London Electric	5	½-¾
Metropolitan Electric Supply	10	12¼-13
—— 4½ per cent. First Mortgage Debenture Stock	100	117-119
National Telephone, Ordinary	5	6½-6⅝
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Non. Cum. Third Pref.	5	6⅛-6⅜
—— 3½ per cent. Deb. Stock	100	106-108
Notting Hill Company	10	8½-9½
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	5	7½-7⅝
—— £4½ shares	4½	6-6⅛
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8½-8⅝
—— 7 per cent. Pref.	5	9-10
Swan United Ordinary	3	2-2½
—— 4½ per cent. Debentures	100	104-107
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4½-4⅝
Westminster Electric Supply, Ordinary	5	8⅞-9½
Yorkshire House-to-House	5	5½-6⅛

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NOTES.

Books Received.—From the office of the New York *Electrical Engineer* we have received "Electrical Engineering Leaflets," by Prof. E. J. Houston, Ph.D., and Prof. A. E. Kennedy, F.R.A.S., vol. 1 being devoted to the elementary grade, vol. 2 to the intermediate, and vol. 3 to the advanced grade.

The Electric Light in Russia.—The use of the electric light is gradually extending in Russia. Experiments with the illuminant in the town theatre and in various business establishments in Riga having given satisfaction, it is proposed to light the public buildings and streets of that city by electricity.

The Canadian Electrical Association.—The annual meeting of the Canadian Electrical Association was held at Ottawa on September 17, 18, and 19. It was expected that the attendance would exceed that of the successful meeting at Montreal last year, and the papers to be read promised to be of fair interest.

Telegraph Charges to India and the East.—We learn that the London Chamber of Commerce is in correspondence with similar corporations throughout the kingdom, inviting their co-operation with a view to securing a substantial reduction in the rates at present charged for telegrams to India and the East.

Electricity in Egypt.—A considerable addition is shortly to be made to the plant at the central electric stations in Cairo and Alexandria. Two Brown and Boveri dynamos, driven by a pair of 200-h.p. steam-engines by Sülzer and Winterthur, are to be put down at Cairo, and a 100-h.p. engine and dynamo at Alexandria.

Aluminium Conductors.—M. E. C. Grammont has erected an overhead line made of aluminium for the transmission of electric energy between his two factories at La Plaine and Pont de Chérin, in the Isère Department. In order to avoid joints, M. Grammont has satisfactorily soldered the wires end to end with a blowpipe.

Helmholtz Memorial.—German papers announce that a memorial tablet in honour of Prof. Helmholtz has been affixed to the house, No. 8, Haditzstrasse, at Potsdam, where he was born in 1821. We also hear of an intention to erect a joint monument in memory of Werner Siemens and Helmholtz in front of the Technische Hochschule at Charlottenburg.

Military Telegraph Lines on the St. Gotthard.—It is announced that the military department of the Swiss Bundesrath has requested a credit of 56,000f. for the purpose of establishing telegraphic connections on the St. Gotthard. It is proposed to erect wires between Andermatt and Dissentis and Dissentis and Olivone, and to join up the military lines on St. Gotthard to the Gletsch Station in the Upper Rhone valley.

Electric Safety Lamps.—As the result of experiments the Berlin fire brigade have decided to adopt the Fiehn and Sehrndt accumulator lamp. It is designed to light rooms in which explosive materials are stored, or which are filled with easily-explosible gases. It burns for about 10 hours and weighs 5½lb. The lamp, it is stated, has already been adopted by the fire brigades of Frankfort on-Main, Bremen, Stettin, Chemnitz, Halle-a-S., Elbing, and by Krupp, of Essen.

Electric Railways in the United States.—It is computed that there are at the present time 850 electric railways in the United States, with more than 9,000 miles of track, with 2,300 cars, and representing a capital investment of 400,000,000dol. An idea of the rapidity and magnitude of the extension of this system of traction may be formed when the fact is noted that in 1887 the electric roads in the United States numbered only 13, with about 100 cars in operation.

Electric Lighting in India.—Applications have already been submitted to the Government of Bengal for permission under the Electric Lighting Act to lay mains in the streets of Calcutta for the benefit of the general public. The question of lighting the streets by electricity is, owing to the gas company's contract with the Corporation, one for the future, a correspondent writes; but he expects to find the Eden Gardens and the Calcutta maidan ere long lighted by the new illuminant, in addition to the jetties and several public offices.

Electric Tramways in Warsaw.—A request for a concession for building and working an electric tramway system in the Polish capital has been laid before the president of the city, General Bibikoff, by a syndicate at the head of which are Major-General von Guilbert, of Warsaw, and Dr. Zelime, of Leipzig. The Allgemeine Elektrizitäts-Gesellschaft is interested in the project. The capital of three million roubles will be furnished by the Commercial Bank of Warsaw. The scheme has yet to be submitted to Governor-General Shouvaloff.

Resuscitated.—A lineman, who has been for 14 years in the employ of the Rochester Gas and Electric Company, recently received a shock from a "live" wire at Rochester N.Y., and lay apparently dead for six minutes. He recovered consciousness after being subjected to the d'Arsonval treatment. His right hand and wrist were badly burned, but he was otherwise uninjured. The wire that he came in contact with carried 1,600 volts, and he seemingly received the full voltage by short-circuiting the line with his body.

The Berlin Electric Tramways.—As we announced last week, the first electric tramway, built by Messrs. Siemens and Halske, was opened in Berlin on September 10. The line runs from Badstrasse, Berlin, N., to Pankow. The gauge is 1·435 metre. The current is supplied through overhead wires from the central station in Pankow. Ornamental Mannesmann steel-tube standards are used. The rails are utilised for the return current. The motor cars have 18 sitting and 12 standing places. The motor is under the car floor. The cars run at a speed of from 10 to 12 miles an hour, and the fare for the whole distance of about two miles is only 10 pfennige—say, 1½d.

The Pacific Cable.—With reference to the note under this head in our last issue (p. 284), it is now stated that the negotiations for the contract with the Hawaiian Republic were conducted with the greatest secrecy, and when it became known that it was signed a meeting of the Honolulu Chamber of Commerce was immediately called, at which the British and German members protested against the granting of any exclusive right, as it would preclude the construction of an English, German, or French Pacific cable for the next 20 years, since the Hawaiian group are the only islands in the North Pacific which afford a landing-place for so long a cable.

An Important Financial Operation in Copper has, it is stated, just been concluded. It is announced that Messrs. Rothschild have obtained a very large interest in the shares of the well-known Anaconda Mine of the United States. The capital of this company is about six millions sterling, and the shares of 25dol. each are expected to be

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shortly offered in the London market at a substantial premium. The figure spoken of is £7, which would make the capitalisation of the company nearly £8,500,000. Large profits have been made by this mine in the past, and the acquisition by English capitalists of a large interest in the company will exercise considerable influence on the position of the copper market.

Marking Incandescent Lamps.—The *Sprechsaal* speaks of the advantage of numbering each lamp as it leaves the works; but the plan of ticketing them with an adhesive label takes too much time, and there is the risk of the ticket coming off. It therefore recommends writing directly on the glass, and gives the following formula: Dissolve 36 grammes of sodium fluoride and seven grammes of potassium sulphate in 500 grammes of water. In another vessel 14 grammes of zinc chloride are dissolved in 500 grammes of water and 65 grammes of hydrochloric acid are added to the solution. Immediately before writing the inscription, equal parts of the two solutions are mixed and applied to the glass either with a pen or a pencil. An indelible inscription is said to be the speedy result.

What it is.—Electricity "is as old as life, as mysterious as death, and as everlasting as eternity. It is as bright as the stars of heaven, it is as silent as the graves of men. It is as powerful as fate, as subtle as sympathy, as swift as thought. And it is developing as rapidly as Jack's fabulous beanstalk." At least, so thinks a well-known Detroit journal; and the biting gnats in Jersey City must also be of this opinion if we attach any importance to the somewhat sarcastic remarks of a New Yorker visiting that place. "What a stranger might take for fenders on the trolley cars are not," he says, "fenders at all, but mosquito catchers. When the mosquito is struck the catcher, with a sudden twist, tosses its body from the track. More mosquitoes than citizens are killed yearly by the trolleys."

Electrotherapy.—The American Electro-Therapeutic Association has just held its fifth annual meeting at the College of Physicians and Surgeons of Ontario, in Toronto. Herr von Bergmann, who attributes much of the progress in cerebral surgery to improvements in technique and instruments, employs a circular saw operated by electricity for dividing the outer table of the skull. Through the energy and activity of Dr. Georges Apostoli, president of the French Society of Electrotherapy, the society now has an official organ, *Le Bulletin Officiel de la Société Française d'Electrothérapie.* The latest electrical instrument is the autoscope, devised by Dr. Kerstein, of Berlin, for examination of the larynx and trachea. It consists of a thick tube, 20cm. long, ending in a gutter-like point; the tube being tightly screwed to a Gaspero electroscope at a right angle. It is stated that when this instrument is correctly introduced the patient readily breathes through it, a complete view of the larynx and trachea being thus obtained.

A New Electric Alarm.—The *Revue de l'Electricité* describes an alarm apparatus, the joint production of a French engineer, M. Laville, and M. Plisenier, a Belgian. The "Vigilant," as it is called, has recently been tried at the Brussels Northern Railway Station, and is designed to take the place of the ordinary electric bells and to be attached to safes, doors, windows, etc. The least disturbance of the object to which it is fixed causes a loud-sounding bell to ring. When used as a fire-alarm the apparatus is furnished with a multiple-combination letter-lock, which can only be opened by someone in possession of the key word. There are no springs or electromagnets in the apparatus, and the inventors claim that it cannot get out of order. The Belgian State telegraphic engineers have, it is stated, experimented with and expressed their approval of the apparatus.

Measurement of the Specific Inductive Capacities of Water, Alcohol, etc.—In *Phil. Mag.* Mr. Reginald A. Fessenden says that it has hitherto been accepted that the high values for the specific inductive capacities for water, alcohol, and some other similar liquids which have been obtained by various experimenters are correct. If this were so, Maxwell's rule for the relation between specific inductive capacity and the index of refraction would not hold in these cases, and the phenomena of dispersion, etc., have been called in to explain this anomaly. The author finds, however, from the results of experiments described in the paper, that these high values are not correct, but that the true values are in every one of these substances very nearly equal to those called for by the theory. The cause of the errors lies in the fact that electrolysis gives a capacity effect. It is for this reason that Kohlrausch's method almost always gives erroneous results, as what is measured is not the resistance of the electrolyte, but its impedance.

The Telephone Service.—A correspondent writes: "The Duke of Norfolk has initiated a series of investigations with reference to the telephone. The men whom he has entrusted with the mission of enquiry have, too, a personal significance, which is not calculated to lessen the importance which is being attached to the incident. They are Mr. Preece, the chief electrician of the General Post Office, and Mr. H. C. Fischer, controller of the Central Telegraph Office, both of whom are known to entertain strong opinions as to the assumption by the State of the telephone interest. They are at present in Germany studying the system in operation in that country." By the way, the *Elektrotechnische Zeitschrift* of Sept. 12, remarks, in noting the above fact, that Mr. Fischer is a born German, and that he at one time belonged to the Hanoverian Telegraph Direction. He left Germany when he was fifty and came to England to extend his knowledge, got into the Telegraph Department, and gradually worked his way up the ladder of promotion.

Gases of the Helium and Argon Type.—Herr Bohuslav Brauner has treated cerite with sulphuric acid and then with water. A gas is produced showing the negative behaviour of nitrogen, but mixed with some hydrogen; the same mineral when heated in a vacuum alone, or with a sulphate, yields gases belonging to the helium and argon type; this was also noticed with several other Bohemian uranium ores. Pitchblende, from Pribram, shows a peculiar behaviour; with a feeble current, in a Geissler tube, with aluminium electrodes, it emits a blue-violet light; with a stronger current, a crimson light. With the spectroscope, the lines, D_3 and D_2, are seen together with 19 other lines or groups of lines—three of the lines belong to hydrogen and one in the red to argon. After some time the helium lines disappear entirely, one by one, then the hydrogen lines go, and an extremely feeble, but characteristically fluted hydrocarbon spectrum makes its appearance. The absorption of helium by aluminium proves its metallic character.

A New Constant Battery.—M. Morisot, professor at the Faculté des Sciences in Bordeaux, has recently brought before the meeting of the Association Française pour l'Avancement des Sciences a new type of battery. An outer vessel contains the positive pole, a plate of retort carbon, which is immersed in the depolarising liquid, composed of one part of sulphuric acid and three parts of a saturated solution of potassium bichromate. The bichromate must be dissolved before the acid is added, and the saturation is kept up by crystals of bichromate contained in a short funnel in the upper portion of the liquid. A porous pot standing in the depolarising liquid contains a weak

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solution of caustic soda (specific gravity about 1·05). The plate of amalgamated zinc which forms the negative pole is in a second porous pot inside the first, and filled with a strong solution of caustic soda (specific gravity about 1 25). The E.M.F. of the cell is 2·5 volts at the outset, and remains above 2·4 volts for at least 10 hours. The interior resistance is about 0·8 ohm, but it varies according to the thickness and quality of the porous pots. M. Morisot attributes the increase of 0·4 volt of E.M.F., compared with the ordinary bichromate cell, to the substitution of the alkaline solution for the ordinary acid.

Electrical Coal-Cutting.—A number of gentlemen connected with the coal industry were recently invited to East Plean Colliery, Stirlingshire, to witness the working of a coal-cutter patented by Mr. Hurd. The principle of the machine is a bar-cutter worked electrically from a motor cased within the apparatus, and the advantages claimed are: The bar cuts independently of position, either under or, as in the East Plean Colliery, between seams of two qualities of coal; there is almost absolute steadiness, a great feature in any electrically-driven machine; the electric motor and gearing, the parts being few and simple, are built into the machine, which, being cased over, forms a substantial tool which would not suffer much from falling roof or other such accident; an ingenious principle is introduced of entering the cutter-bar from the reverse side of the machine, to which a self-cleaner may be applied; it then makes its own holing, and can, when required, shear the coal vertically; this bar can be separately adjusted while the machine is in motion to meet any irregularities of the road, and keep the holing continuously in the best position. The machine was worked downhill on an incline varying from 1 in 5 to 1 in 10, cutting, it is stated, 3ft. 6in. deep at the rate of about one yard in two minutes.

The Condensation of Fumes by Static Electricity.—In the current number of the Columbia School of Mines *Quarterly*, Mr. Melvern W. Iles, superintendent of the Globe Smelter, Denver, Col., calls attention to the desirability of some cheap method for the generation of static electricity to condense the fumes from volatile metals. The writer thinks that the subject of the volatility of gold, silver, and lead has not received sufficient attention, many substances, like copper, which is classed by the practical metallurgists as being non-volatile, being found to suffer at least 6 per cent. loss in fumes. He believes that the invention of a cheap method for the generation of static electricity will enable metallurgists to save a very large amount annually in the reduction of all the well-known volatile metals, and considers the matter one which will repay the attention of electricians. The article refers to the well-known experiments of Lodge in clearing an atmosphere clouded with dust and smoke, and calls attention to a United States patent granted to Alfred O. Walker, dated May 25, 1886 (No. 342,548), on a "Process of Depositing Solid Particles Suspended in the Air or Gas," and also to an article by E. Dieudonné, printed in *La Lumière Electrique* in the spring of 1886, on "The Condensation of Fumes by Static Electricity."

The Electro-Harmonic Society.—A smoking concert will be held on Saturday, September 28, at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., commencing at eight o'clock. The following is the programme—Part I.: part song, (*a*) "Come Live with Me" (Maunder), humorous quartette, (*b*) "Quite Sufficient" (M.S.), the "Schartau" Part Singers; song, "The Tempest of the Heart" (Il Trovatore) (Verdi), Mr. Arthur Appleby; pianoforte solo, "Caprice sur les Airs de Ballet d'Alceste de Gluck" (Saint-Saëns), Mr. Alfred E. Izard; humorous recitation, "Astronomy Made Easy" (Anon.), Mr. W. G. Churcher; ballad, "Take a Pair of Sparkling Eyes" (Sullivan), Mr. John Bartlett; flute solo, Mr. Frederick Griffiths; humorous song, Mr. Herbert Schartau. Part II.: old melody, "Genevieve" (specially arranged), the "Schartau" Part Singers; new song, "The Gay Hussar" (Sullivan), Mr. Arthur Appleby; humorous recitation, "My Haircutter" (Turner), Mr. W. G. Churcher; song, "The Wonders of the Deep" (Jude), Mr. William Bradford; madrigal, (*a*) "It was a Lover" (Sixteenth Century), humorous quartette, (*b*) "Only Once" (M.S.), the "Schartau" Part Singers; flute solo, Mr. Frederick Griffiths; humorous song, Mr. Herbert Schartau. Messrs. T. E. Gatehouse and Alfred E. Izard will be the musical directors.

The Trolley Question.—The Chicago tramway magnate, Mr. Charles T. Yerkes, states that he has found in the overhead trolley system a very valuable auxiliary to his cable trunk lines, and his advocacy of electricity is due entirely to his belief in its dividend-earning capacity. The introduction of the trolley on the lines of the North and West Chicago street railroads, formerly operated by horses, he considers to be an important recommendation for the electric motor, and the announcement of the result of this transformation and its effect upon the receipts and expenditure of the companies are, he says, gratifying to all who are interested in this method of propulsion. Mr. Yerkes has given at an interview his reasons for advocating the trolley system, and he explains the relations of the cable companies to the auxiliary electric companies. He affirms that as soon as a line is equipped electrically the traffic increases, and that those lines now worked by electricity show an improvement of 30 per cent. The net earnings for seven months of operation by electricity manifested an increase of 24 per cent. compared with the corresponding months of last year; and while more passengers have been carried than was the case a year ago, the working expenses have been less. It is reported, by the way, that electric funeral cars are shortly to be introduced in Chicago. They are "intended to furnish a cheap means of reaching the various cemeteries with as as little discomfort as possible."

Queensland and the Pacific Cable.—The question of laying a cable across the Pacific, a Sydney paper to hand says, has been brought forward again by the announcement made by Mr. J. G. Ward that the New Zealand Government intended to introduce legislation for the purpose of co-operating with Canada in the establishment of the Pacific cable. Queensland is also in sympathetic accord with Canada on this subject, but some friction appears to exist over the matter between Queensland and New South Wales. The Postmaster-General (Mr. Cook) says some comment was made about the want of foresight shown by the Queensland Government in not joining in the guarantee to the Eastern Extension Company. The Queensland Postmaster General, in explanation of the attitude of his Government, claimed that there had been an understanding at the Hobart Postal Conference that if Queensland joined in the guarantee to the Eastern Extension Company the New South Wales Government would help Queensland in regard to the Pacific cable, and he complained of New South Wales not having adhered to this agreement. Mr. Cook denies that any such understanding was arrived at, and points out that if Queensland had joined in the guarantee with the other colonies she would have gained materially. The Queensland Government were invited to contribute a certain sum towards the Eastern Extension guarantee, but nothing towards the subsidy to which all the other colonies contribute a proportional amount. Had Queensland assented to this very favourable arrangement, the journal adds, the rates for her cable messages would have been reduced from

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9s. 4d. to 4s. 9d. per word, and she would have had to pay nothing under the guarantee, for the result of the year's cable work has been so satisfactory that the guarantee to the Eastern Extension Company has been more than covered, and none of the colonies will now have to pay anything under it.

The Spectrum of Carbon from the Electric Furnace.—In a recent communication to the Académie des Sciences, M. Deslandres stated that M. Moissan recently pointed out that the carbons which he uses for his electric furnace are purified by the passage through them of the large currents employed. As it is very difficult to purify carbon by the chemical way, M. Deslandres emphasises the importance and interest of this property of the electric furnace, especially to spectroscopists, who often use pure carbon in qualitative analysis. It was on this account that M. Deslandres paid special attention to the statement of M. Moissan, and carried out an investigation to verify its correctness. M. Moissan placed at M. Deslandres' disposal two carbon electrodes, a positive and a negative, 20cm. long and 5cm. thick, which he had made use of in some electric furnace experiments. M. Deslandres took from each electrode small pieces of carbon at distances of 15cm., 10cm., 5cm., and 1cm. from the arc. He found that the pieces which were taken from the electrode at some distance from the arc showed the ordinary impurities of carbon — namely, alkaline metals, together with copper, iron, and silicium. When, however, he came to examine the pieces which had been taken close up to the arc, the bands denoting impurity finally disappeared, with the exception of the calcium bands, which, although very much reduced, always remain visible, a fact which M. Deslandres attributes to the lime wall of the furnace, which is probably partly volatilised when large currents are used. M. Deslandres attributes this purification of carbon to a purely physical cause, the impurities being much more volatile than carbon, and being therefore vaporised before it. The purest carbon was obtained from the mushrooms which form on the negative, and with one of these mushrooms M. Deslandres obtained a spectrum which contains fewer impurity bands than any of the spectra hitherto published.

The Bolton Technical School.—Technical education is making great strides in Bolton, and new premises have recently been acquired in connection with the scheme of extended scientific and practical instruction. Upon lately visiting the technical school, Prof. Beaumont, representing the City and Guilds of London Institutes, paid the institution a very high compliment by observing that in point of instruction and arrangement of work the classes were second to none in the country. In order that instruction may be organised in machine drawing, building drawing and construction, physics, applied mechanics, steam, metallurgy, and woodwork, the rooms at Mawdsley-street have been rearranged. On the top floor is a well-appointed room, 60ft. by 30ft., laid out with specially prepared tables and seats for drawing purposes, and in close proximity is an apartment of similar size fitted with benches and tables, and six electrical connections for students taking up practical physics, electric lighting, and magnetism and electricity. The hosiery-room has been converted into a handsome class-room for the advanced applied mechanics, steam, horticulture, and mining students. Alterations effected in the large lecture-hall have given increased seating capacity, and the place has been thoroughly beautified. As the gas-engines have been disposed of the building is lighted by electricity from the Corporation mains, Mr. J. H. Rider, the electrical engineer, having speedily completed the connection. The space under the gallery is converted into a dark-room for the use of photography students, and demonstrations are to be given in the various processes, fully illustrated by new apparatus. Woodworking, carpentry and joinery, cardboard work, typography, and theoretical metallurgy will be taught on the ground floor, and as the woodworking-room is near the lower lecture-hall, greater facility is secured in passing from the classroom into the workshop for practical instruction. The bench accommodation has been increased, and is now sufficient for 50 pupils. In the basement the subjects taken will be chemistry, practical metallurgy, and machine drawing, special arrangements having been made in connection with the latter class, as it is anticipated that there will, at least, be 200 pupils. Last session the accommodation for the practical metallurgy and assaying class was altogether inadequate, and double the number of furnaces have been built, testing-benches have been erected, and the room has been renovated and furnished. The higher portion of the premises facing Bridgman-place has been gutted and replaced by a spacious entrance hall and well-adapted classrooms. The basement is to become an important part of the institution, the floor having been lowered a foot and the windows improved and enlarged to secure better light. This section will be devoted to engineering, wood-turning, metal-turning, and working, moulding, and smithy work. In the south end, separated from the workshops by a glazed partition, is a large engine-house, containing one 100-h.p. high and low pressure engine, supplied by Messrs. Hick, Hargreaves, and Co. This will provide the whole motive power, as well as drive two large dynamos placed in the centre of the room, and arranged to be used for instruction in the electric-lighting classes. Mains are laid from the dynamos to the switch-board for class demonstrations, and other means are adopted for the advantage of students in this branch of scientific work. The engine-room affords accommodation for instruction in applied and theoretical mechanics, steam, magnetism, and electricity, and electric lighting. This department will be under the control of an engineer to be appointed shortly, and he will also have charge of the engineering tools and lighting. Adjoining is the boiler-house, fitted with one of Messrs. Hick, Hargreaves, and Co.'s high-pressure Lancashire boilers. The main portion of the basement constitutes the engineering workshop, which is exceedingly well equipped, and when in full swing will represent a modern works of no mean order. Three lines of shafting are fixed to brackets on the pillars, and serve for the engineering, wood and iron turning, and brass finishing. Engineers' benches for 50 students are placed immediately under the windows, good light being thus obtained. There are also two continuous beds of lathes for 20 students, a range of iron hand turning lathes, drilling and miling machines, cutter grinder, screw-cutting lathes, small finishing lathes for iron and brass turning, shaping and planing machines, grindstones, and bench and hand saws. At the entrance to the basement is the moulding and smithy department, with hearths and all accessories. The weaving-room, on the ground floor, is naturally one of the principal characteristics of the institution. Not the least interesting feature of the curriculum of the technical school is the teaching of the Russian language. Bolton does considerable trade with Russia, and it is necessary for many workmen in the engineering and cotton-spinning industries to possess a knowledge of the language of that country. Through a generous offer made by Mr. W. M. Musgrave, J.P., the committee has been enabled to arrange for a class for imparting instruction in Russian, and has secured the services of a highly qualified teacher.

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A NARROW-GAUGE ELECTRIC LOCOMOTIVE.

BY R. W. WEEKES, WHIT.SCH., A.M.I.C.E.

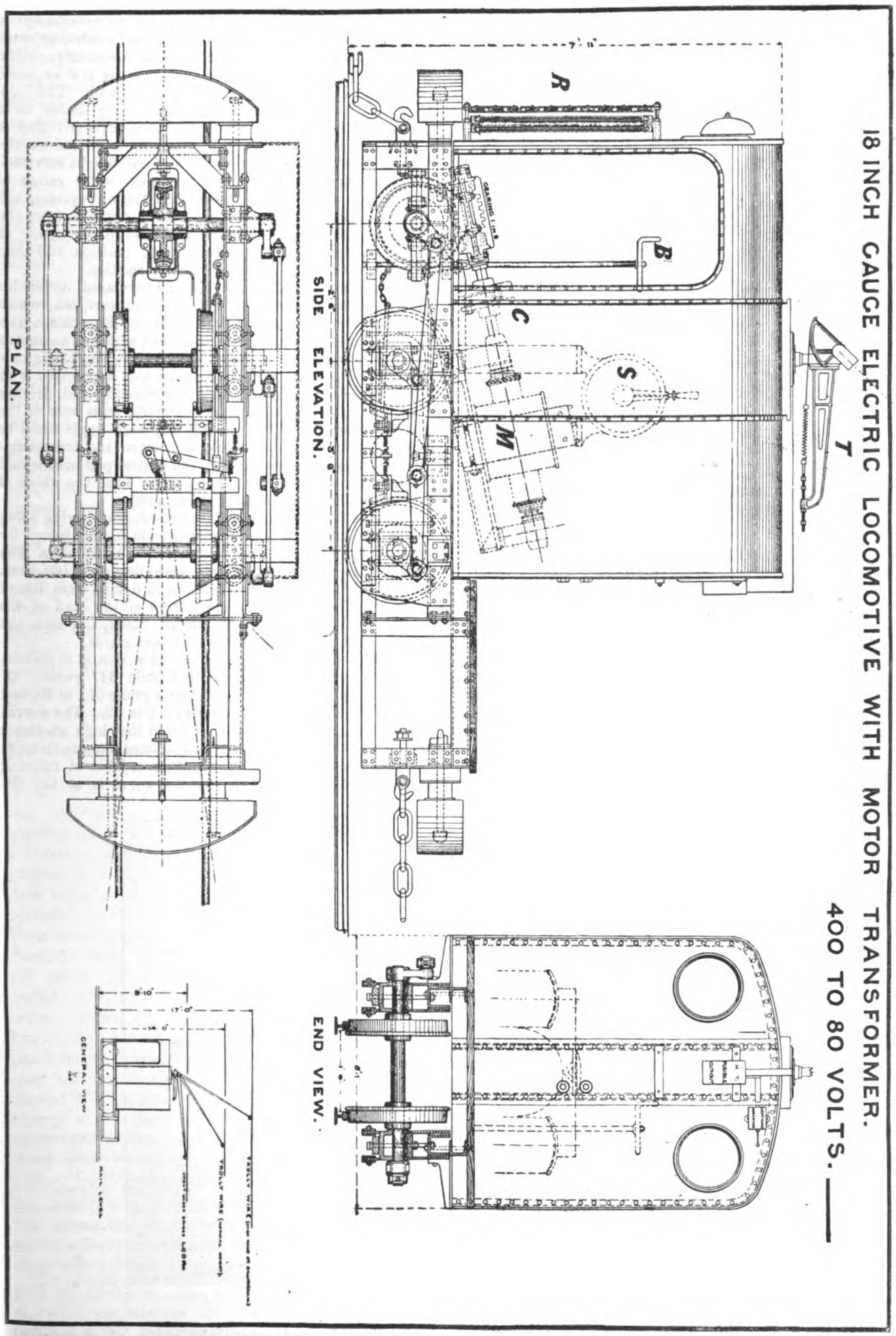

Fig. 1.—General Views of the Locomotive.

A new electric locomotive with most interesting features has recently been built by the associated firm of Messrs. Easton, Anderson, and Goolden for the 18in. line running between the electrical school at St. Mary's Barracks,

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Chatham, through the dockyard, into the submarine mining establishment at Gillingham. This locomotive is the result

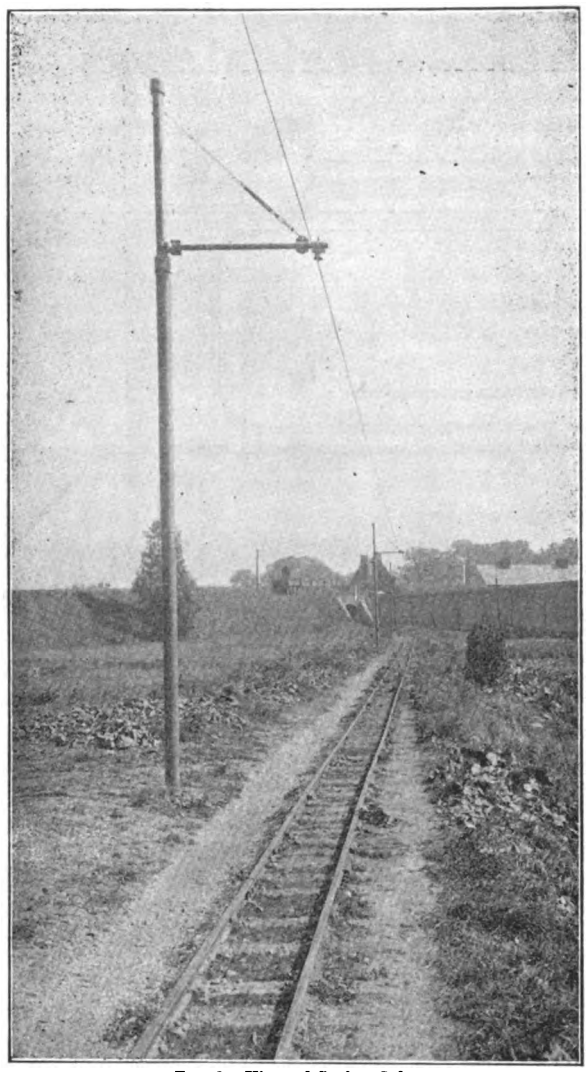

FIG. 2.—View of Spring Pole.

of the accumulative ideas of many workers. Major A. Bagnolds, R.E., first talked the matter over with Mr. Gisbert Kapp when the latter delivered his course of lectures on "Alternating Currents" at Chatham in 1891. The matter assumed a more definite form at the end of 1892, when the following leading essentials of design were fixed:

The locomotive was to be used on a siege railway of 18in. gauge, and hence was to work as noiselessly as possible. To assure the mounting of stiff grades, as much load as possible to be carried on the locomotive. The centre of gravity of the locomotive to be as low as could be arranged, and the wheel base to be small. The locomotive to be capable of starting when fully loaded on a grade of 1 in 22. The motor to be so arranged that it could act as a constant-current transformer to reduce the 400 volts of supply to 80 volts for search-light service—the idea of this being that a much wider range of fortifications could be connected to a 400-volt system, and that when projectors were wanted at a distance from the generating station, the locomotive would, under cover of the night, transport the projectors into position and then supply the necessary current by transformation.

As private assistant to Mr. Kapp, I prepared, under his direction, a series of designs with different gears, etc., which we submitted from time to time to Major Bagnolds. The confined space at our disposal, combined with the numerous requirements, rendered the subject a most interesting one. Finally, it was determined to make the locomotive with two bogies, each complete with electromotor and driving gear. A central platform for carrying guns was to be placed across these two. In this way each bogie could be used separately for light work, and when the transportation of heavy guns was needed, the central platform would be laid on the two to bear the weight. Then the whole of the load would come on the driving axles.

These details and the method of worm-gear driving being determined on, specifications, with drawings, were issued for one section of this composite locomotive—*i.e.*, one bogie. The order was placed with the above-named firm early last year. At the first trials some modifications in details were found necessary, but, thanks to the energy of the staff of the electrical school, these were quickly made, and now the locomotive is regularly used to transport stores.

The Line.—The total length of this 18in. line, as at present equipped for electric traction, is 1 mile 347 yards. Of this length quite a quarter is laid on a grade of 1 in 30, and another longer section has a grade of 1 in 22. The curves also are sharp, but as it was considered that high gradients and sharp curves would be found in all lines running through fortifications, the locomotive was made capable of running on the existing line. The sharpest curve is at the St. Mary's Barracks end, where the radius of curvature is 36ft. The conductor is constructed on the overhead trolley

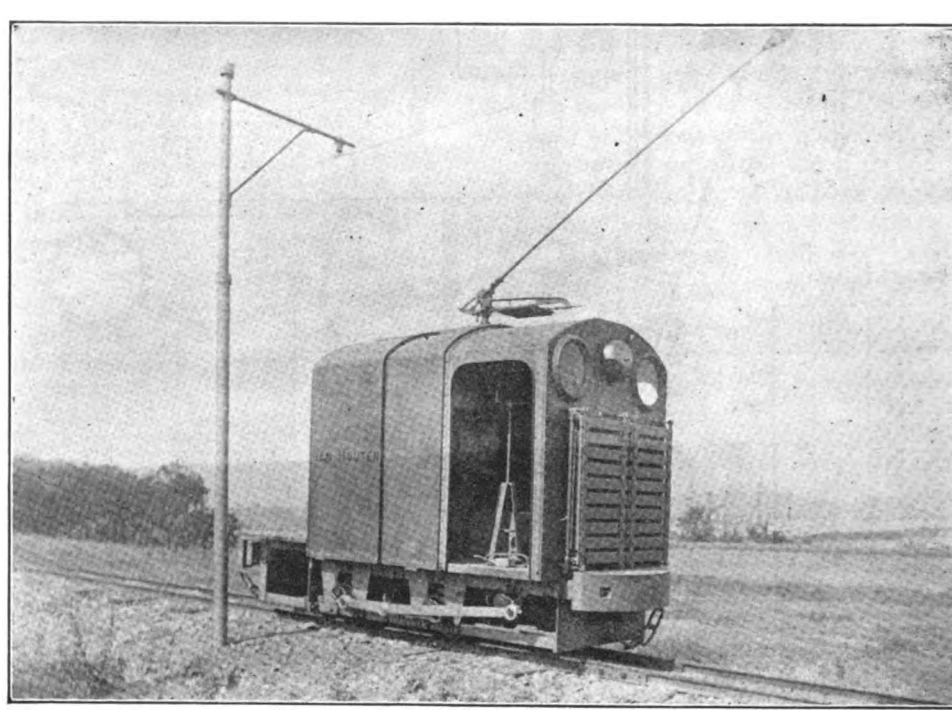

FIG. 3.—View of Locomotive on Steep Grade.

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system, the rails forming the return; these are bonded together by what are known as the Chicago bond. A hole is drilled in the web of the rail, into which the two ends of the copper bond is placed. These ends are spit cylinders formed on the copper rod. A tapered steel pin is then driven into the centre of the head of the bond, which expands the copper into intimate contact with the rails. The trolley wire or main conductor is supported for the most part on brackets from poles at the side of the track, and at the curves the usual overhead construction has been followed. Owing to several arches to be passed under, the height of the trolley wire varies very much, as will be seen from the small shackles, etc., have been supplied partly by the General Electric Company of America and partly by R. Blackell. The wire itself is of No. 0 gauge, and was supplied by T. Smith and Co., of Halifax. A swivelling trolley bar is also used, which allows of the position of the trolley wire relative to the centre of the track being varied considerably. The whole of the erection of this line was carried out by the electrical school staff, which seems to contain a representative of every branch of engineering.

Locomotive.—The various details of the locomotive now in use can be seen from Fig. 1, while Fig. 3 is a perspective view of the locomotive standing on the steep grade. As will be gathered from these views, the reduction of 8 to 1

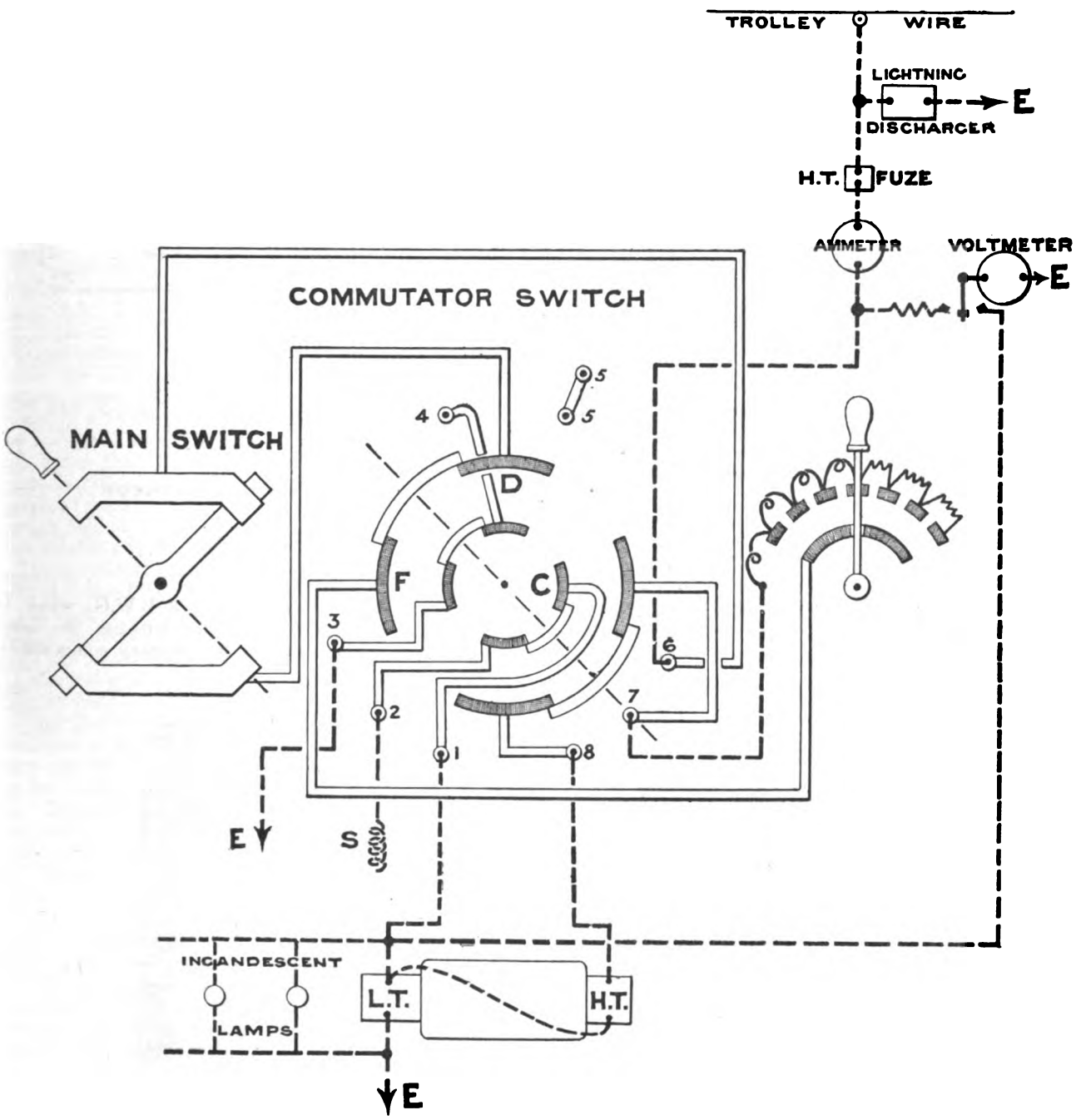

FIG. 4.—General Connections

general view in Fig. 1. A spring pole (Fig. 2), devised by Major Bagnolds, is used on the dockyard portion of the lines. In these, as can be seen from the illustration, the arm carrying the trolley wire is hinged on the pole and supported in its horizontal position by an adjustable spring. This allows the wire to give a little to the collector, and prevents the tendency of the trolley to jump when passing the points of support.

The bracket poles consist of wrought-iron tubing, tapering from 3in. to 4in. diameter, which were taken from some of the plant supplied for the abandoned Suakim railway; these, in a few instances where extra height is required, are set in old smooth-bore guns. The trolley-wire fittings, is effected by worm gearing running in oil in a cast-iron case. The worm wheel is connected to the driving wheels by connecting rods, as shown. The desire to keep these connecting rods as nearly horizontal as possible, results in the motor being slightly tilted. These driving wheels are 1ft. 10in. diameter, the distance between the centres being 3ft. 6in. The worm-wheel shaft is not rigidly connected to the motor, and all the thrust is taken by the two bearings in the worm case. The driving coupling (C, in Fig. 1) consists of two flanges having projecting pins on their adjacent faces. The pins are on different radii, and are connected together by a leather strap. When this strap is removed, the flange keyed to the motor shaft is perfectly

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free to revolve, so that the motor-generator can be used for supplying search-light apparatus. The motor has the Manchester type of field, but is Gramme wound. The wound with 512 turns of No. 10 B.W.G., connected to a 64 part commutator, the calculated armature resistance being 0·222 ohm. The low-voltage secondary circuit is

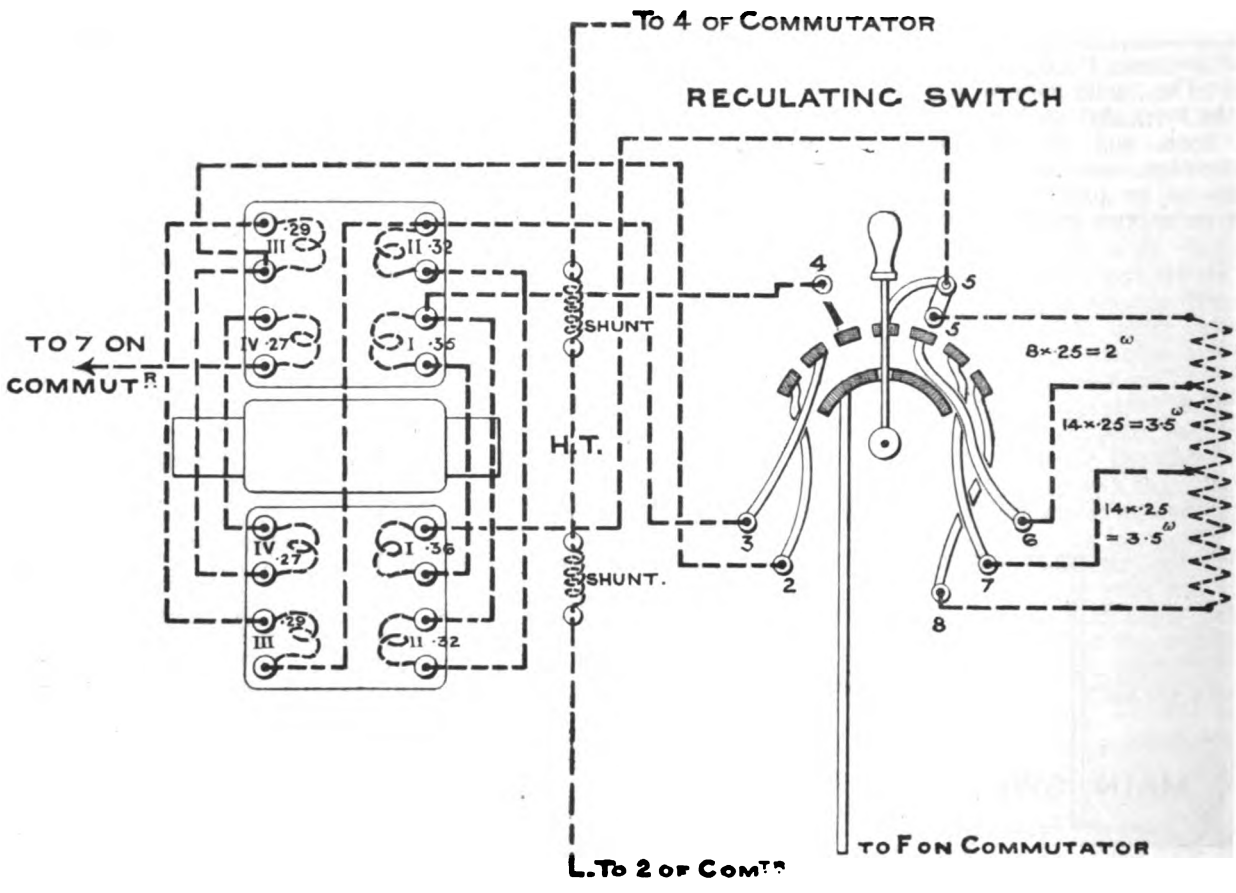

Fig. 5.—Diagram of Regulation Connections.

ratio of number of turns in the two windings is 1 to 4, so that with the connection shown in Fig. 4 the voltage in the high-tension commutator is approximately four-fifths of that

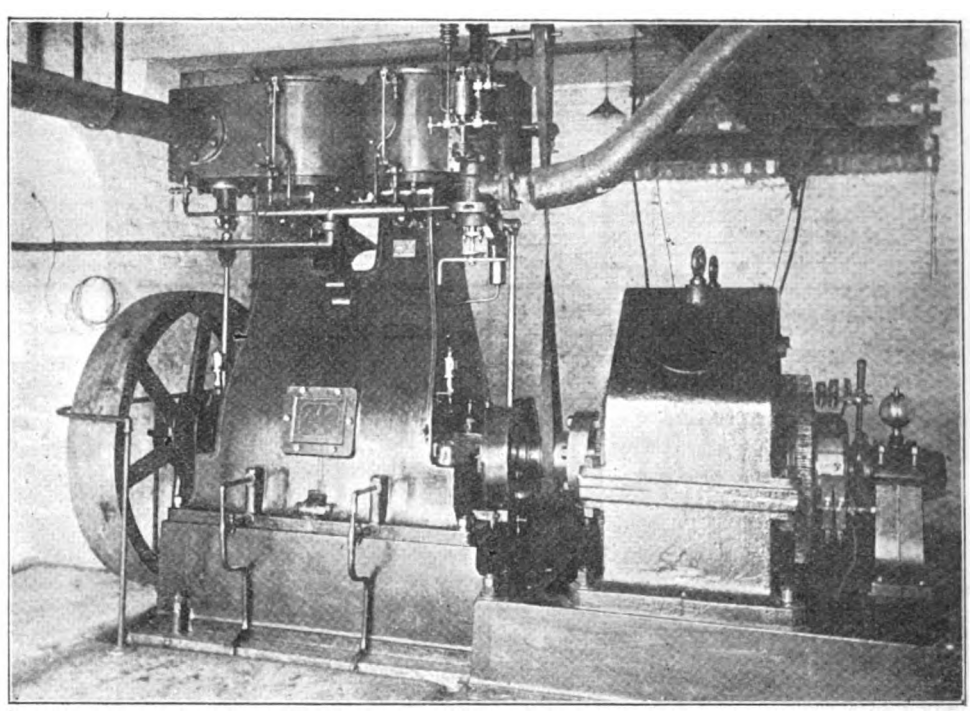

Fig. 6.—View of Engine-house.

of the line—*i.e.*, 320 volts. The voltage, then, at no load on the low-tension commutator is 80 volts.

The following are the details of the windings of the motor-generator. The primary circuit of the armature is

The resistance of this armature circuit is 0·018 ohm. The shunt winding of the field magnet consists of 772 turns of No. 15 B.W.G. and 2,290 turns of No. 14 B.W.G. in series, or 3,062 turns in all, having a resistance of 14·5

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ohms when hot. The series wire on the field is No. 7 B.W.G., 432 turns being provided, and wound in four sections, whose resistances are as follows:

Sections, Fig. 5.	Resistance in ohms.
I.	0·71
II.	0·64
III.	0·58
IV.	0·54
Total	2·47

The field thus has two windings, both shunt and series, the latter being used for purposes of regulation, as shown in Figs. 4 and 5. The switch gearing is contained in a cast-iron case, S, supported over the centre of the motor (Fig. 1). There are two handles, one on either side of this—the one to make or break the circuit and to reverse the motor, and the other for regulating purposes. These two handles are made interlocking, so that the switching and reversing handle can only be moved while the regulating handle is on the last contact, which puts all resistance in. Also the regulating handle is locked when the current reversing the commutator switch is vertical—*i.e.*, in the off position.

From the diagram the connection will be readily followed with a little care. The added resistance in starting is nine ohms, which is cut out by the first three steps of the regulating switch. The next steps increase the speed by cutting out series-turns. When the machine is being used for a constant-current transformer the projector is connected across the L.T. commutator, as shown in Fig. 4, by incandescent lamps. The terminal voltage here will vary considerably with the load, but it acts in a similar manner to the resistance usually placed in series with the projector, and hence the drop is not objectionable. The rate of transformation is not dependent on the speed, and it is found, as would be expected, most economical to run with a weak field at high speeds. Then the resistance in the high-tension side is small.

The locomotive has now been in use for some time, and has been christened the "Van Houten," because, according to one of the staff, it is "the best and goes farthest." Its total weight is about five tons, and when loaded with four tons more the motor takes about 450 amperes at 350 volts on the steepest grade. The speed then is from four to five miles an hour.

Power Station.—The power station (Fig. 6) is situated in the casemates of St. Mary's Barracks. In one of the casemates there are two 20-h.p. (nominal) locomotive-type boilers—one by Ruston and Proctor, and the other by Robey and Co. These boilers are worked at 120lb. pressure, are each equipped with an injector and a feed-pump, and feed into a 4in. wrought-iron steam-main supplied by Messrs. Willans and Robinson. The pipes of this main have "loose" flanges, and are jointed with copper rings.

In an adjoining casemate is located a 42-unit direct-coupled generator, of the Kapp type, supplied by Messrs. Johnson and Phillips. The dynamo, which is compounded, is of the four-pole type, with drum armature, and yields 105 amperes at 400 volts. This dynamo is driven direct by a vertical compound 60-h.p. semi-enclosed engine, by Robey and Co., at a speed of 200 revolutions per minute. The engine is governed on the throttle by a Pickering governor.

A compact overhead traveller, to lift two tons, is located above the dynamo, the pistons and rods of the engine being dealt with by ordinary lifting tackle through a trapdoor in the floor above. This is, I believe, the only slow-speed direct-coupled generating plant for electric traction in this country. It is of specially robust construction, and although it has occasionally been pulled up pretty smartly by "shorts," no damages whatever have resulted.

A handsome switchboard completes the installation of the power station. The switches and instruments are by the Westinghouse Company, and are of their standard traction types. The marble panels of the board are neatly set in a T-iron frame, to which they are secured by half-round brass filleting and bolts. The lightning dischargers are of the Wirt "charred wood" pattern, and the shunt coil of the generator is protected by a Steele's patent "potential arrester."

Great credit is due to the staff at the electrical school for this development of electric traction for military purposes, and especially to Major Bagnolds, who has boldly tackled and overcome the numerous hitches inevitably connected with pioneer work. The whole of the generating plant has been erected by his staff, and the fireproof construction of the switchboard was entirely designed and carried out at Chatham.

A PORTABLE MAGNETIC-FIELD TESTER.*

BY PROF. W. E. AYRTON, F.R.S., AND T. MATHER.

In June, 1892, the authors described a portable ballistic galvanometer of the moving-coil type before the Physical Society of London,† but owing to delay in the manufacture the instrument was not ready in time to be shown at the meeting. Since that time many experiments have been carried out with the instrument then described, and the galvanometer has been used to map out the stray fields of various dynamos, and to explore the magnetic fields in the neighbourhood of switchboards of electric light stations.

This first instrument possessed several structural defects, but the most serious faults experienced were, first, inconstancy of zero, and, second, a considerable want of proportionality between quantity and swing—or strength of field and swing of the needle—a proportionality which theoretically should hold for all angles of whatever magnitude. Eventually both these difficulties were traced to magnetism in the suspended coil, a property which, although every care may be taken to prevent contamination of the material with iron, is very difficult to eliminate. After much experimenting, with a view to avoiding traces of magnetism in the suspended parts of swing-coil galvanometers, a satisfactory method was devised early in 1894, and a description of a reflecting galvanometer fitted with an improved coil appeared in the technical papers in the autumn of that year.‡ Meanwhile, an improved form of the portable ballistic galvanometer had been prepared, in which the details of construction were considerably modified, so as to make the working parts more accessible, and an improved shape of coil was employed.

FIG. 1.

For ballistic galvanometers the best shape of the cross-section of the moving coil is not the same as that for a current galvanometer, for whilst a current instrument should have a coil whose section approximates to two circles touching one another, a ballistic instrument is improved by using a sector-shaped coil of narrow angle, as shown in Fig. 1.

The instrument as now made is shown in Fig. 2, whilst Fig. 3 gives a sectional plan. A circular base provided with levelling screws carries a C-shaped magnet, M (Fig. 3), between the poles of which the coil, C, is suspended. The discharges are led into and out of the coil by the suspensions, one being a straight phosphor-bronze strip and the other a spiral surrounding the straight strip. Both suspensions are attached to an ebonite head near the top of the central tubes, this head serving the purpose of zero adjustment; and the arrangement is such that the whole of the suspended parts can be readily withdrawn.

The arm carrying the suspension head overhangs the scale, so as to permit of the pointer making one or more complete revolutions, and in this way an instrument having a very long range is obtained. For example, the body of the instrument shown in Fig. 2 has a diameter of 4in., and the length of the scale, reckoning only one revolution of the pointer, is about 11in. As it is quite possible to use 1½ or 2 revolutions without straining the suspensions unduly, we have here an instrument with a scale as long as that of an ordinary reflecting galvanometer (18in.) in a very com-

* Paper read at the meeting of the British Association at Ipswich

† *Electrical Engineer*, June 14, 1892.

‡ See *Electrical Engineer*, October 5, 1894.

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pact form. To increase the range of the instrument still further, and to make the instrument suitable for measuring the stray magnetic field in close proximity to dynamos, pole-pieces, etc., a switch, S (Fig. 3), is arranged to put a resistance coil, R, in series with the suspended coil, thus multiplying its range by 10. The same switch, when moved to the position marked O F F, breaks the circuit of the instrument and lifts a spring, L, which clamps the coil. A short-circuit key, K, on the front of the galvanometer is used to bring the pointer to rest, for when this is pressed the motion of the coil becomes aperiodic.

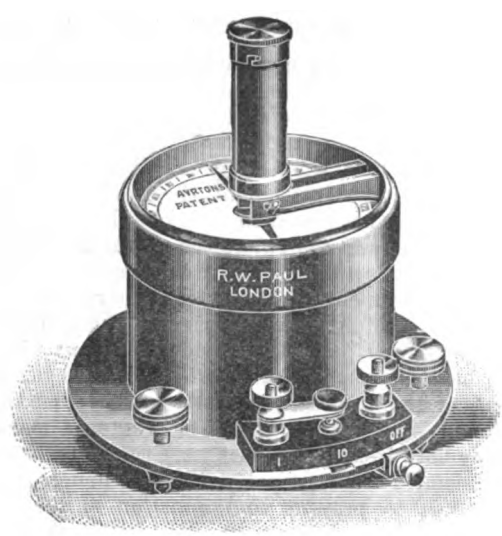

FIG. 2.

The scale of the instrument is divided into 200 parts, and as a field tester the sensibility is such that with an appropriate test coil the scale reads off directly the strength of field in C.G.S. units.

For some purposes it is convenient to have the scale graduated in microcoulombs, in which case, besides reading the quantity directly, the swing of the instrument multiplied by the total resistance of the galvanometer circuit measures

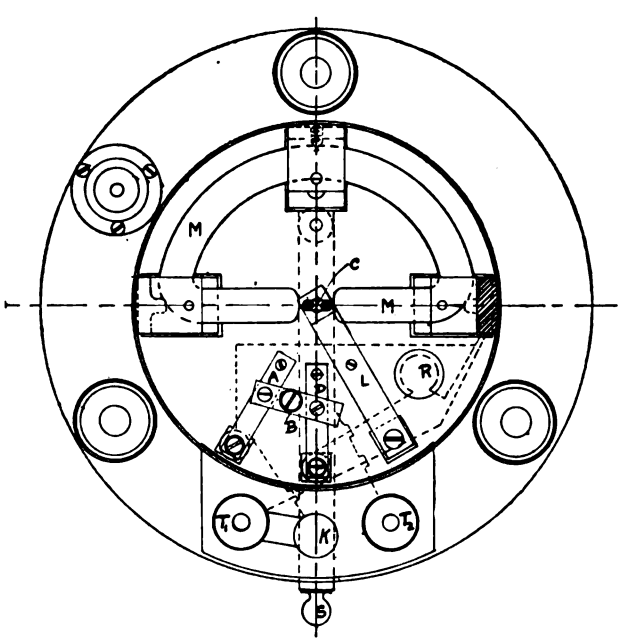

FIG. 3.

the total change of induction through that circuit. Such a scale is useful in testing iron for permeability, etc., for by suitably arranging the resistance of the circuit the scale reading can be made to read off $\mathfrak{B}$, the induction density, directly.

THEORY OF PORTABLE FIELD TESTER.

Let H = strength of magnetic field in C.G.S. units;
n = number of turns in coil;
r = mean radius in centimetres of coils projected on medial plane;
l = mean length of each coil, supposed rectangular;

Let I = moment of inertia of moving parts;
ω = angular velocity imparted to coil by discharge;
a = torque exerted by suspension when twisted through unit angle;
N = total change of flux through circuit;
R = resistance of the circuit;

Then, assuming that the plane of the coil is parallel to the field of magnet when the discharge passes, we have—

Moment exerted by the coil at any instant

$$= 2\,r\,l\,n\,\mathrm{H}\,\frac{d\,\mathrm{N}}{d\,t}\,\frac{1}{\mathrm{R}} \quad . \quad . \quad . \quad . \quad (1)$$

$$= y\,\frac{d\,\mathrm{N}}{d\,t} \text{ (say)} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

therefore angular impulse $= \int y\,\frac{d\,\mathrm{N}}{d\,t}\,d\,t \quad . \quad . \quad . \quad . \quad (3)$

$$= y\,\mathrm{N} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

This must be equal to the angular momentum imparted to the coil,

hence $$\mathrm{I}\,\omega = y\,\mathrm{N} \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

Now, the energy stored in the coil at the completion of the discharge is

$$\frac{\mathrm{I}\,\omega^2}{2}, \text{ and is therefore} = \frac{\mathrm{I}}{2}\left(\frac{y\,\mathrm{N}}{\mathrm{I}}\right)^2 \text{ from (5)}$$

$$= \frac{y^2\,\mathrm{N}^2}{2\,\mathrm{I}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Now, all this energy is expended in twisting the suspensions through an angle, ϕ, where ϕ is the swing of the pointer. But the work done in the process is

$$\int_0^{\phi} a\,\theta\,d\,\theta,$$

$$= \frac{a\,\phi^2}{2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

Equating (6) and (7) we have

$$\frac{a\,\phi^2}{2} = \frac{y^2\,\mathrm{N}^2}{2\,\mathrm{I}},$$

from which $$\phi = \pm\frac{y}{\sqrt{a\,\mathrm{I}}}\,.\,\mathrm{N};$$

i.e., ϕ is proportional to N.

Appended we give a table showing the relative swings produced by discharging a given quantity of electricity through a given length of wire wound into coils of various shapes. From this it will be seen that the long narrow coil has considerable advantage over common shapes as regards sensibility. At the same time, it permits of much greater range than the forms which necessitate the use of a central core in order to obtain the requisite strength of field to give good shielding from external disturbing fields. The use of a narrow coil also enable swings to be taken in either direction without reducing the range, whereas instruments with cores necessarily have their maximum range of 180deg. reduced to something less than 90deg. if arranged to read either right or left of zero.

TABLE showing Calculated Swings produced by Discharging a Constant Quantity of Electricity through a Single Turn of Wire bent to Four Coils of Various Shapes.

Assuming: 1st, constant magnetic field.
2nd, ,, control.
3rd, ,, length of wire in coil.
4th, ,, diameter of wire in coil.
5th, no added mass.

Shape.	Proportions.	Swing.	Relative moment of inertia.
Rectangular ...	length = breadth × ∞	100	0
,, ...	$l = 10\,b$	94	2·32
,, ..	$l = 2\,b$	75·6	23·1
Square.....	$l = b$	61	50
Circular	—	71	60·7
Rectangular ..	$2\,l = b$	45	68·1
,, ..	$10\,l = b$	14·5	97·6
,, .	$\infty\,l = b$	0	100

The standard exploring coil used with this instrument is shown in Fig. 4. The coil, C, is fixed to a spindle, A,

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which is able to rotate through 180deg. in the handle, B. A spring attached to it inside the handle gives it the impulse necessary. The coil is first set back and then engages with a click which is released by the trigger, T.

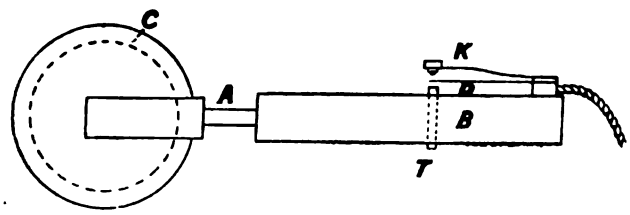

FIG. 4.

This trigger is actuated by the pressure on the key, K, which after closing the galvanometer circuit depresses the lower spring, D, and releases the coil. The area and number of turns in the coil, C, are so calculated that the deflections in the galvanometer give induction in C.G.S. units per square centimetre.

SOME EXPERIMENTS MADE WITH LORD KELVIN'S PORTABLE ELECTROMETER.*

BY ARTHUR SCHUSTER, F.R.S.

Experiments made during a recent journey to Switzerland have shown to the author how easily observations on atmospheric electricity are performed by means of Lord Kelvin's portable electrometer. The instrument is easily carried in a knapsack to almost any place within reach of the mountaineer, and the observations are readily made in a short space of time in the way long ago described by Lord Kelvin. The object of the experiments was to learn, if possible, whether the electric force at great heights is sensibly different from that at the sea-level. But owing to the difficulty of comparing together observations made in valleys with those made on mountain peaks, the measurements made during the past month were entirely of a tentative character more for the purpose of gaining experience with the instrument and to obtain guidance for future work than with a view of bringing home definite results. The numbers which are given in this brief account have only a relative value, as they are referred to an arbitrary unit. A number of experiments made in fine weather in the centre of a small meadow in front of the hotel at Pontresina gave on the average about 30 for the electric force, which is smaller than that found in England under similar circumstances. Thus, on September 13, at Ipswich, on a plot of grass rather more sheltered by surrounding meadows than the Pontresina meadow, the author found the electric force to be over 80. On the so-called Diarlezza Pass the number found was as high as 147, while on the Isola Pirs, a rocky island, projecting well out of the surrounding glacier, it was 116. On August 19 the instrument was taken to the top of the Glushaint (12,000ft.), which consists of a ridge of rocks just wide enough for one man to stand upon. The electric force reached the number 816, while on a snowfield a few hundred feet below the top the force was only 170. The top of the Schafberg gave 357 for the electric force. On the Morteraheb glacier the numbers were, as a rule, very low, except on one occasion when a strong downward wind was blowing, but even then the force only went up to 42. Half-a-mile below the snout of the glaciers the numbers found were very irregular, and seemed to depend on the direction of the wind. On one occasion, when the wind was frequently changing, being sometimes up and sometimes down the valley, a negative electrification was observed whenever the current of air was from the glacier. This was probably due to negative electrification caused by the glacier stream, in a way similar to that in which a similar electrification is produced by waterfalls.

The daily variation was observed on one day by taking observations every half-hour from nine to twelve o'clock and every hour in the afternoon until seven o'clock. A principal maximum of 36 was observed at 11 a.m. The numbers then fell irregularly till four o'clock, when the electrification was only 14. After that time it rose to 31 at 5 p.m. and 29 at 6 p.m., and fell to zero at 7 p.m. The wind, which had been blowing up the valley all day, changed in direction between the two last observations, and was blowing downwards at seven o'clock. The author does not draw any conclusions from his observations, but does not believe that a mere difference in the configuration of the ground is sufficient to account for the great differences in electric force observed.

* Abstract of paper read at the meeting of the British Association at Ipswich.

SOME LESSONS IN TELEPHONY.*

BY A. R. BENNETT, M.I.E.E.

In 1846 Mr. J. C. Bourne, in his history of the Great Western Railway, wrote: "It is a well-established truth in the history of trade and commerce that the traffic between two cities or countries will increase in proportion to the facilities of communication afforded, or to the speed, security, and cheapness with which such communication can be effected."

The truth of this proposition had been demonstrated before Bourne's time in respect to common roads and waterways; since, experience has shown that no town can prosper unless it be connected with the railway system of the country. In the beginning, several towns, by spending large sums in opposing Railway Bills, succeeded in keeping off the main lines of communication, but the magnitude of the error has long since been manifest, and great efforts have been made, not always successfully, to repair it.

Bourne's axiom may nowadays be admitted to embrace telegraphic and telephonic facilities, for places wanting these are at a great disadvantage as compared with more fortunate neighbours. If commerce may be held to constitute the life-blood of a modern nation, roads, railways, and waterways are the arteries through which this blood is conducted, while telegraphs and telephones may be compared to the nerves which feel out and determine the course of that circulation which is a condition of national prosperity. Given two nations, equal or nearly so in natural resources and in the talents and industry of their inhabitants, that one will succeed the better in commerce which possesses the most extended and cheapest facilities for transport and general intercommunication.

It has recently been demonstrated that the United Kingdom is deficient in at least two of these essentials—railways in their branch or feeder form, and telephones, which are the natural feeders of the telegraphs. Why this is so may best be discovered by ascertaining by what means, technical or economical, those nations which have most conspicuously outstripped us have attained their superiority. For the purposes of this paper, in which is considered the telephonic branch of the question, the countries of Europe have been divided into three groups: (1) well telephoned; (2) indifferently telephoned; (3) badly telephoned.

A country may most properly be said to be well telephoned when its smaller towns and villages enjoy facilities, for the existence of a few large exchanges in the capital and chief towns does not entitle it to that distinction. For instance, France, Russia, and Portugal all possess good exchanges in their capitals, but are nevertheless badly telephoned as a whole, since their smaller towns and villages are excluded from the circle.

On the other hand, we find that the Grand Duchy of Finland, under the same crown as Russia, but enjoying a different system of administration, is distinctly well telephoned. Its area exceeds that of the United Kingdom, although the greater part of its surface consists of lake, forest, and waste; its staple industries are fishing and agriculture, yet a telephonic map of Finland discloses a veritable network of lines. All the towns and many of the villages possess exchanges, while the capital, Helsingfors (population 65,000), is one of the best-telephoned cities in the world. Last year there were 198 exchanges in Finland, or one to each 12,626 inhabitants. In the United Kingdom there were but 578 exchanges, or one to each 65,537 inhabitants. In proportion to its population, Finland had therefore more than five times as many centres of telephonic activity as the United Kingdom. Even the people of the Aland Islands, in the middle of the Baltic, find a telephone exchange so well worth paying for at the rates which are found remunerative by the exploiting company, that in Mariehamn, the capital, there is an exchange telephone to every 13 inhabitants. In fact, Mariehamn is entitled to the distinction of being the best-telephoned town in the world. Another Finnish town, Viborg (population 22,344), has an exchange telephone to every 33 inhabitants, and other towns have one to 36, 37, 39, and 40.

* Paper read at the meeting of the British Association at Ipswich.

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Norway is, however, the best-telephoned country on the whole. It has a population of 2,000,000, and has little to rely upon in the world's struggle but agriculture, forestry, and fishing. Seventy per cent. of its total area is uncultivable, and another 24 per cent. is forest. It has but half-a-dozen towns, the bulk of the population residing in widely-scattered villages. Yet it

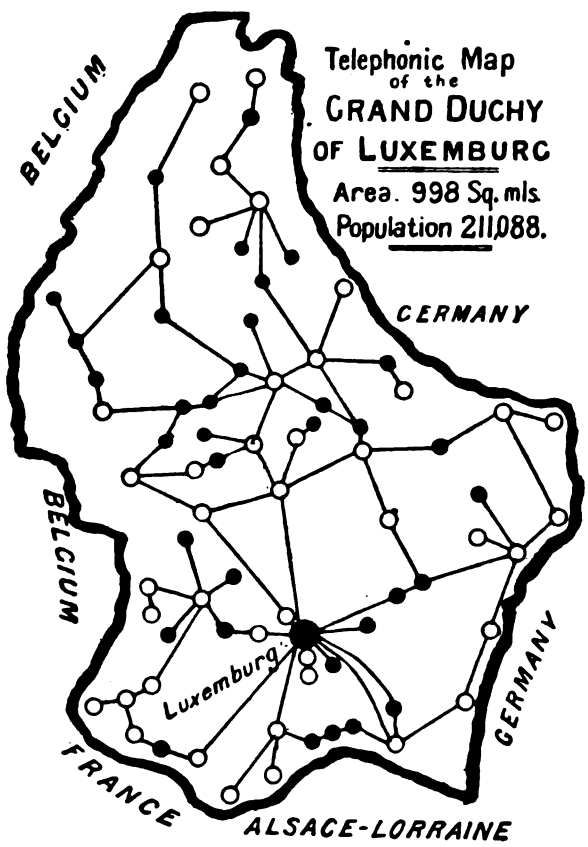

FIG. 1.

possesses no fewer than 256 telephone exchanges, or one exchange to each 7,812 inhabitants—more than 8½ times the number in the United Kingdom in proportion to population.

Sweden, which takes the second place in the list of well-telephoned countries, possesses greater resources than Norway. It has a population of not quite 5,000,000, one-half of which is dependent on agriculture. Eighty per cent. of the people live outside the towns. A radius of 43½ miles round Stockholm, equal to 5,945 square miles, is unquestionably the best-telephoned bit of country in the world. Almost every village possesses two competing telephone exchanges, while rival systems of trunk lines place the whole of this large area in practically instantaneous communication.

Denmark, with its population of 2,250,000, and its staple industries of agriculture and dairy farming, takes an honourable place, having 152 telephone exchanges within its borders, or one to every 14,639 inhabitants.

The four foregoing countries form a class by themselves. Their telephonic development has been due almost exclusively to companies and co-operative societies. In Sweden the State has of recent years assumed an important position in respect to telephony, but its proceedings and tariffs have been based upon the previously-established procedure and tariffs of the companies whose systems it found in operation. In the two next instances the development attained is due wholly to the fostering care of the respective States.

Switzerland has a population of 3,000,000, which is served by 155 telephone exchanges, or one to every 19,355 inhabitants. All its towns and many of its villages possess telephone stations and are connected by trunk lines. The Grand Duchy of Luxemburg contains 998 square miles, which is also precisely the area of Dorsetshire. The respective populations are 211,088 and 194,517. Agriculture is the staple industry of Luxemburg, as it is of Dorset. We find, however, that while Luxemburg possesses 59 telephone switchrooms within its borders, or one to each 3,577 inhabitants, Dorset has only three—Dorchester, Weymouth, and Poole—or one to each 64,839. Luxemburg had last year 1,315 exchange lines; Dorset, at the present moment, possesses about 70. In Luxemburg, there is an exchange telephone to every 160 souls; in Dorset, one to 2,778. Every town and village of Luxemburg is in telephonic communication with the capital and with each other. The accompanying maps, Figs. 1 and 2, exhibit the different stages of development attained in these two equal areas. And yet many counties are worse off than Dorsetshire is.

This completes the list of the European countries which are well telephoned, and constitute Group I. The least favourable result in this group is 328 persons per exchange telephone. A considerable jump must be made in order to reach the best country of Group II. This is the Imperial German Post Office territory, which comprises the whole of the German Empire except Bavaria and Wurtemberg. Within its limits there was last year one telephone to every 449 inhabitants. It is noteworthy to remark that the comparatively good position taken by Germany is due to the fact that Berlin, Hamburg, Frankfort-on-Maine, and other chief towns possess very large exchanges, Berlin and Hamburg being amongst the largest in the world, even Hamburg (population 622,530) having a larger number of subscribers than London (population 5,600,000). But the small towns and villages are not developed, and rural intercourse by telephone is practically non-existent. The reason is that the German Post Office has a uniform tariff, applicable equally to the capital and to the smallest village, which, although reasonable for Berlin, is prohibitive for the country folk. The results obtained in Bavaria and Wurtemberg are not dissimilar.

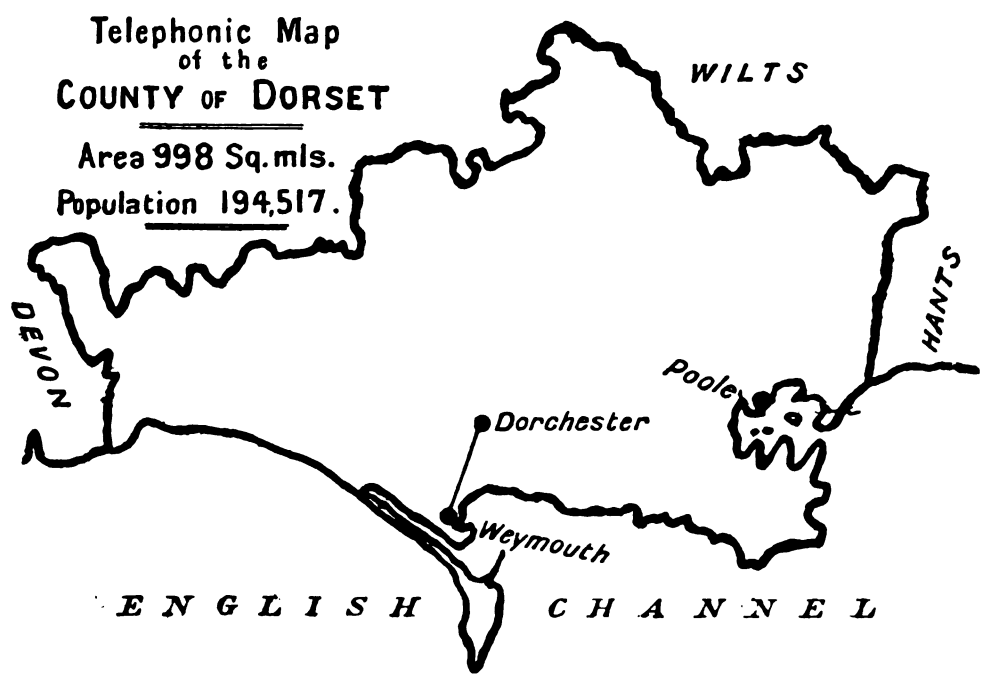

FIG. 2.

Wurtemberg has a lower initial tariff than the Imperial Post Office, but is hampered with restrictions which operate against rural development. The United Kingdom comes next in order of merit, with one exchange telephone to every 636 persons. These figures, like the continental ones, refer to last year. The ratio has improved since then both at home and abroad, but the relative positions remain unchanged.

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TABLE A.

Order of merit.	Country.	Population.	Number of exchange telephones.	Number of persons to each exchange telephone.	Characteristics of management.
	Group I.				
1	Norway	2,000,917	13,943	144	Very low rates. Local management of exchanges. Good rural intercourse. No competition.
2	Sweden	4,784,981	32,602	147	Very low rates. Local management of exchanges in part. Good rural intercourse. Competition.
3	Luxemburg	211,088	1,315	160	Very low rates. Central management, but with delegated control in some cases to local authorities. Good rural intercourse. No competition.
4	Switzerland	3,000,000	17,422	172	Ditto ditto ditto.
5	Denmark	2,185,335	10,325	211	Very low rates. Local management of exchanges. Good rural intercourse. No competition.
6	Finland	2,412,135	7,351	328	Very low rates. Local management of exchanges. Good rural intercourse. Competition.
	Group II.				
7	Imperial German Post Office Territory	41,796,966	93,131	449	Fair rates for urban subscribers in large towns; high rates in small towns. Highly centralised management. Bad rural intercourse. No competition.
8	Bavaria	5,594,982	12,400	451	Ditto ditto ditto.
9	Wurtemberg	2,036,522	4,430	459	Low rates for urban subscribers, but with regulations tending to restrict suburban and rural intercourse. Centralised management. No competition.
10	United Kingdom	37,880,764	59,569*	636	High rates, with regulations unfavourable to development outside towns. Local management in part. Practically no competition.
11	Holland	4,669,576	7,263	643	High rates in three chief towns; low rates elsewhere. Management chiefly centralised. Bad rural intercourse. No competition.
12	Belgium	6,136,444	8,757	700	High rates in large towns; low rates of recent origin in small towns. Centralised management. Indifferent rural intercourse. No competition.
	Group III				
13	France	38,343,192	26,772	1,432	High rates; subscribers also pay capital cost of their installations, except in Paris and Lyons. Centralised management. Bad rural intercourse. No competition.
14	Spain	17,800,000	10,984	1,618	High rates in large towns. Recently introduced reduced tariff for smaller towns. Local management. Bad rural intercourse. No competition.
15	Austria	23,895,413	14,574	1,640	Fair rates, but subscribers pay capital cost of their installations. Centralised management. Bad rural intercourse. No competition.
16	Italy	30,535,848	12,067	2,530	High rates in large towns, except in Rome, where competition exists; low rates in Rome and in small towns, but under strict Government supervision. Bad rural intercourse. No competition except in Rome.
17	Hungary	17,463,473	5,563	3,139	High rates in towns; very low rates in villages, but combined with regulations which tend to restrict communication between towns, suburbs, and villages. Partly local management. No competition.
18	Portugal	5,000,000	1,483	3,371	Exchanges only in Lisbon and Oporto. Fair rates. No rural intercourse. No competition.
19	Russia	97,151,789	7,415	13,102	Highest rates in Europe in chief towns; high rates in smaller towns. Partly local management under Government rules. Bad rural intercourse. No competition.

* Company, 58 367; Post Office, 1,202.

Holland and Belgium complete Group II. A wide gap intervenes between this and Group III., or badly-telephoned class. The best country of this is France, with one exchange telephone to every 1,432 persons; and the worst is Russia, which can only show one to each 13,102 inhabitants.

The foregoing facts are presented in Table A, which also gives the leading characteristics of the management in each country.

The questions naturally arise, "To what causes are such vast differences in development to be ascribed?" and "Why is the United Kingdom, with its preponderating commercial importance and unparalleled spirit of enterprise, only tenth on the list, instead of first?" A study of the table supplies the answer. It shows that telephonic development is proportional to the prevalence of the following features: (1) low rates; (2) local management; (3) facilities for rural intercourse; (4) competition.

At least three of these are characteristic of each of the six countries which compose Group I. On the other hand, they are almost completely absent from Groups II. and III., the leading characteristics of which are (1) high rates, (2) centralised management, (3) neglect of small towns and rural districts, (4) absence of competition.

The operation of low rates and competition in the direction of development is easily understood, but that of local management is not so obvious. Its importance, however, is great. No two places are precisely alike in commercial, social, or topographical features, and telephonic arrangements which suit one neighbourhood admirably are not appreciated in another where other conditions call for other plans. To meet the wants of a locality fully, it is necessary that its character should be thoroughly understood at the headquarters of management, and this, when exchanges are numerous, is not attainable. On the other hand, a Board or council of local men know the requirements of the community exactly; hence the superiority of the results presented by the Scandinavian local companies and co-operative societies. Wherever management is centralised, uniformity is aimed at as a means to economy and of saving trouble, and what appears good in the capital is apt to be imposed on every other town.

In the countries of Group I. special attention is given to small town and rural development. In Switzerland a village council, commune, or other local authority may establish and manage a telephone station in one of its own buildings, and work it with its own employees, simply paying to the State the ordinary subscription of £4. 16s. for the first, £4 for the second, and £3. 4s. for the third and subsequent years, for the privilege of a junction with the general telephone system of the country. Such stations, of which there are 129 in Switzerland, are available for the despatch and receipt of written telegrams as well as of telephone messages. The local authority is authorised to collect a small surcharge on the ordinary tariff to cover expenses incurred for wages, office, and the annual payment to the State.

In Luxemburg a similar system prevails, and is taken advantage of by 34 local authorities. The annual payment to the State for the connection of the municipal station to the general system of the country is uniformly £4 per annum.

France has adopted a similar system, but with a much higher scale of charges and with restrictions which appear irksome to the local authorities, since in 1894 only 10 municipal stations existed in the whole of France.

In the Scandivanian countries and Finland, local management has had even freer play, with the highly satisfactory result disclosed in the table. The third town of Norway, Trondhjem (population 30,000), is worked by the municipality most successfully at very low rates.

(To be concluded.)

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MUNICIPAL ELECTRICAL ENGINEERS.

The number of municipal electrical engineers is rapidly increasing, and the position and status of the individual members will in the future be largely influenced by the actions of the present. It must be admitted that electrical engineers employed in the interests of municipalities have to deal with questions that do not seem of overwhelming importance to other engineers—questions, too, which hardly come within the scope of the work of existing institutions. We have more than once advocated the formation of an Association of Municipal Electrical Engineers, because neither the Institution nor kindred societies seem suited for the discussion of certain questions appealing to this one class, and to that class only. We are informed that the initiative steps have been taken to form a separate association, and it is to point out the grave mistakes that have been made in these initiatory steps that this article is written. Above all things, the officials of such a society should be, like Cæsar's wife, above suspicion, unconnected with trade matters, and absolutely unbiassed in every direction which touches upon the welfare of the members. The position of affairs we are informed, upon what seems to us the best authority, is that an honorary secretary has been elected who is in no way connected with municipal work; who is a kind of roving correspondent upon the staff of a trade newspaper; and, more than all, is a commercial traveller trying to sell the wares of his employers to the men whose society he is to represent. The business acumen of his employers and of himself cannot be overlooked. They look solely to the one result—does this man's travelling pay? He looks to that same result, for if it pays his masters it pays him. But what about the society? Do the members that are, or are to be, believe for one moment that such a man can have their interests at heart? If they believe this, they are less used to the ways of this wicked world than men of such standing and character are apt to be. It is easy to see how the members who really started the movement managed to fall into such an error. It is not the part of a commercial traveller to cry "Bagman, bagman," at all times and at all seasons, but to sink self and ultimate aims at times in order to get into the swim. The honorary secretary—which in this case means more or less the acting secretary—must in the course of his secretarial duties become cognisant of much that is in an embryonic state as regards municipal business. That, in this case, is just what the man wants, so as to be able to direct municipal enterprise through channels that will bring him in the £. s. d. A word here and a word there unconsciously dropped before "our secretary" may be unimportant in the mind of the speaker, but may give the said secretary a clue which, as a business man, he will not be slow to follow up. If an Association of Municipal Electrical Engineers is to succeed, both permanent officials and council must be unconnected with trade. No outsider of the kind we have indicated ought to have been tolerated for a moment in the councils of those taking an active part in the movement. It is just possible that the secrecy that has been observed

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has been the result of this alien importation. No doubt he thinks he can keep the movement to himself till such time as it is too late to remedy the evil. He mistakes his men, and we are pretty certain that unless a change takes place in the constitution of the committee the whole matter will come to an impotent conclusion. This will be a regrettable incident in the history of the Municipal Electrical Engineers, for it will bring about a cleavage of members when what is wanted is unanimity. The being hand-and-glove with a "commercial traveller" will cause every municipal electrical engineer to be doubted by his committee. He will be thought to be recommending certain forms of apparatus, not because he believes the apparatus to be the best of its kind, but because he would like to do a good turn to "our secretary." There is in every town council and on every committee a man who, once he gets a hint of doubtful straightness, will make the engineer's life a burden, if not a shame. Similarly, no member of the committee taking steps to form the society should be connected, directly or remotely, with patents or manufacturers. There are plenty of able men outside these directions, and to these men should be entrusted the work of organisation. We trust we have said no word herein to touch the susceptibility of individuals. That forms no part of our programme. An error has been committed which ought to have been avoided, especially if what we hear is correct—that at the very first meeting the general opinion was to avoid, above all things, "trade connections."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

LIGHT RAILWAYS.

SIR,—We were amused on reading "Dividend's" letter in your issue of Friday last *re* the Derby-to-Ashbourne light railway.

There always were, and will be, "outsiders" who know more about matters than the people who are dealing with them.

However, his statements as to this line generally seem to us about as inaccurate as is his information that we estimated the cost of the permanent-way construction at £1,000 per mile. The fact is, we estimated the cost at over £2,300 per single mile. If "Dividend" is *bonâ fide* and will communicate with us, we will supply him with a copy of the estimate made more than four months ago; but we really cannot enter into a newspaper correspondence with a person whose object does not appear to be to elicit facts, but, for reasons best known to himself, to throw cold water on the scheme.—Yours, etc.,

ALFRED DICKINSON AND CO.

120, Colmore-row, Birmingham, September, 18, 1895.

THE DUBLIN AND KINGSTOWN ELECTRIC TRAMWAY.

SIR,—I beg to call your attention to certain errors in your journal of the 13th inst. (p. 300), in the column headed "Dublin and Kingstown Electric Tramways." You mention "Mr. Robertson," secretary and manager, whereas it should be Mr. J. Clifton Robinson, electrical engineer, and also managing director of the company. I am sorry to trouble you in this matter, but small things of this kind often give rise to confusion. I shall be glad if you will correct the same.—Yours, etc., G. E. CUMMINGS.

88, High-road, Chiswick, W., September 14, 1895.

ELECTRIFICATION AND DISELECTRIFICATION OF AIR AND OTHER GASES.*

BY LORD KELVIN, MAGNUS MACLEAN, AND ALEXANDER GALT.

§ 1. Experiments were made for the purpose of finding an approximation to the amount of electrification communicated to air by one or more electrified needle points. The apparatus consisted of a metallic can 48cm. high and 21cm. in diameter, supported by paraffin blocks, and connected to one pair of quadrants of a quadrant electrometer. It had a hole at the top to admit the electrifying wire, which was 5·31 metres long hanging vertically within a metallic guard tube. This guard tube was always metallically connected to the other pair of quadrants of the electrometer and to its case, and to a metallic screen surrounding it. This prevented any external influences from sensibly affecting the electrometer, such as the working of the electric machine which stood on a shelf five metres above it.

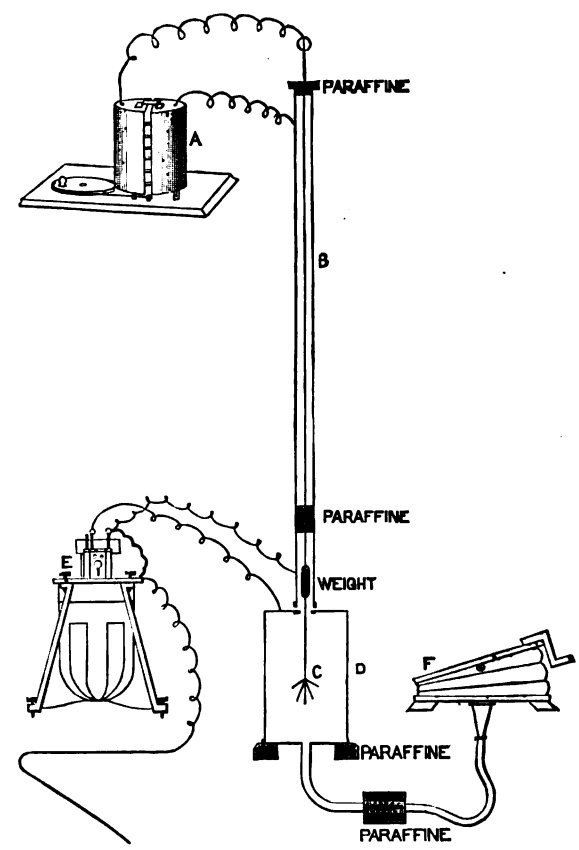

FIG. 1.—(Connected with guard screen, not shown in diagram.)

§ 2. The experiment is conducted as follows: One terminal of an electric machine is connected with the guard tube and the other with the electrifying wire, which is let down so that the needle is in the centre of the can. The can is temporarily connected to the case of the electrometer. The electric machine is then worked for some minutes, so as to electrify the air in the can. As soon as the machine is stopped the electrifying wire is lifted clear out of the can. The can and the quadrants in metallic connection with it are disconnected from the case of the electrometer, and the electrified air is very rapidly drawn away from the can by a blowpipe bellows arranged to suck. This releases the opposite kind of electricity from the inside of the can, and allows it to place itself in equilibrium on the outside of the can and on the insulated quadrants of the electrometer in metallic connection with it.

§ 3. We tried different lengths of time of electrification and different numbers of needles and tinsel, but we found that one needle and four minutes of electrification gave nearly maximum effect. The greatest deflection observed was 936 scale divisions. To find, from this reading, the electric density of the air in the can, we took a metallic disc, of 2cm. radius, attached to a long varnished glass rod, and placed it at a distance of 1·45cm. from another and larger

* Abstract of paper read at the meeting of the British Association at Ipswich.

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metallic disc. This small air condenser was charged from the electric light conductors in the laboratory to a difference of potential amounting to 100 volts. The insulated disc thus charged was removed and laid upon the roof of the large insulated can. This addition to the metal in connection with it does not sensibly influence its electrostatic capacity. The deflection observed was 122 scale divisions. The capacity of the condenser is approximately $\frac{\pi \times 2^2}{4\pi \times 1{\cdot}45} = \frac{1}{1{\cdot}45}$. The quantity of electricity with which it was charged was $\frac{1}{1{\cdot}45} \times \frac{100}{300} = \frac{1}{4{\cdot}35}$ electrostatic unit. Hence the quantity to give 936 scale divisions was

$$\frac{1}{4{\cdot}35} \times \frac{936}{122} = 1{\cdot}7637.$$

The bellows was worked vigorously for 2½ minutes, and in that time all the electrified air would be exhausted. The capacity of the can was 16,632 cubic centimetres, which gives, for the quantity of electricity per cubic centimetre, $\frac{1{\cdot}7637}{16{,}632} = 1{\cdot}06 \times 10^{-4}$. The electrification of the air in this case was positive; it was about as great as the greatest we got, whether positive or negative, in common air when we electrified it by discharge from needle points. This is about four times the electric density which we roughly estimated as about the greatest given to the air in the inside of a large metal vat, electrified by a needle point and then left to itself, and tested by the potential of a water-dropper with its nozzle in the centre of the vat, in experiments made two years ago and described in a communication to the Royal Society of date May, 1894.*

§ 4. In subsequent experiments, electrifying common air in a large gasholder over water by an insulated gas flame burning within it, with a wire in the interior of the flame kept electrified by an electric machine to about 6,000 volts, whether positively or negatively, we found as much as $1{\cdot}5 \times 10^{-4}$ for the electric density of the air. Electrifying carbonic acid in the same gasholder, *whether positively or negatively*, by needle points, we obtained an electric density of $2{\cdot}2 \times 10^{-4}$.

§ 5. We found about the same electric density ($2{\cdot}2 \times 10^{-4}$) of *negative* electricity in carbonic acid gas drawn from an iron cylinder lying horizontally, and allowed to pass by a U-tube into the gasholder without bubbling through the water. This electrification was due probably not to carbonic acid gas rushing through the stopcock of the cylinder, but to bubbling from the liquid carbonic acid in its interior, or to the formation of carbonic acid snow in the passages and its subsequent evaporation. When carbonic acid gas was drawn slowly from the liquid carbonic acid in the iron cylinder placed upright, and allowed to pass, without bubbling, through the U-tube into the gasholder over water, no electrification was found in the gas unless electricity was communicated to it from needle points.

§ 6. The electrifications of air and carbonic acid described in Sections 4 and 5 were tested, and their electric densities measured by drawing from an air-pump a measured quantity of the gas† from the gasholder through an indiarubber tube to a receiver of known efficiency and of known capacity in connection with the electrometer. We have not yet measured how much electricity was lost in the passage through the indiarubber tube. It was not probably nothing; and the electric density of the gas before leaving the gasholder was no doubt greater, though perhaps not much greater, than what it had when it reached the electric receiver.

§ 7. The efficiency of the electric receivers used was approximately determined by putting two of them in series with a paraffined tunnel between them, and measuring by means of two quadrant electrometers the quantity of electricity which each took from a measured quantity of air drawn through them. By performing this experiment several times, with the order of the two receivers alternately reversed, we had data for calculating the proportion of the electricity taken by each receiver from the air entering it, on the assumption that the proportion taken by each receiver was the same in each case. This assumption was approximately justified by the results.

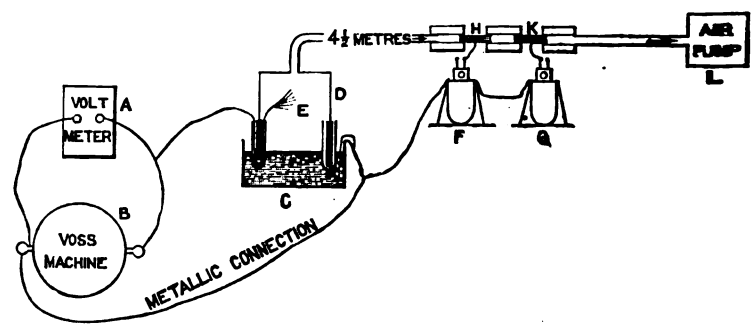

FIG. 2.

§ 8. Thus we found for the efficiencies of two different receivers respectively 0·77 and 0·31 with air electrified positively or negatively by needle points; and 0·82 and 0·42 with carbonic acid gas electrified negatively by being drawn from an iron cylinder placed on its side. Each of these receivers consisted of block tin pipe, 4cm. long and 1cm. diameter, with five plugs of cotton wool kept in position by six discs of fine wire gauze. The great difference in their efficiency was no doubt due to the quantities of cotton wool being different, or differently compressed in the two.

§ 9. We have commenced and we hope to continue an investigation of the efficiency of electric receivers of various kinds, such as block tin, brass, and platinum tubes from 2cm. to 4cm. long, and from 1mm. to 1cm. internal diameter, all of smooth bore and without any cotton wool or wire gauze filters in them; also a polished metal solid, insulated within a paraffined tunnel. This investigation, made with various quantities of air drawn through per second, have already given us some interesting and surprising results, which we hope to describe after we have learned more by farther experimenting.

§ 10. In addition to our experiments on electric filters we have made many other experiments to find other means for the diselectrification of air. It might be supposed that drawing air in bubbles through water should be very effective for this purpose, but we find that this is far from being the case. We had previously found that non-electrified air drawn in bubbles through pure water becomes negatively electrified, and through salt water positively. We now find that positively electrified air drawn through pure water, and negatively electrified air through salt water, has its electrification diminished but not annulled, if the primitive electrification is sufficiently strong. Negatively electrified air drawn in bubbles through pure water, and positively electrified air drawn through salt water, has its electrification augmented.

§ 11. To test the effects of heat we drew air through combustion tubes of German glass about 180cm. long, and 2½cm. or 1½cm. bore, the heat being applied externally to about 120cm. of the length. We found that when the temperature was raised to nearly a dull red heat, air, whether positively or negatively electrified, lost little or nothing of its electrification by being drawn through the tube. When the temperature was raised to a dull red heat, and to a bright red, high enough to soften the glass, losses up to as much as four-fifths of the whole electrification were sometimes observed, but never complete diselectrification. The results, however, were very irregular. Non-electrified air never became sensibly electrified by being drawn through the hot glass tubes in our experiments, but it gained strong positive electrification when pieces of copper foil, and negative electrification when pieces of carbon, were placed in the tube, and when the temperature was sufficient to powerfully oxidise the copper or to burn away the charcoal.

§ 12. Through the kindness of Mr. E. Matthey, we have been able to experiment with a platinum tube one metre long and one millimetre bore. It was heated either by a

* "On the Electrification of Air," by Lord Kelvin and Magnus Maclean.

† The gasholder was 38cm. high and 81cm. in circumference. Ten strokes of the pump raised the water inside to a height of 8·1cm., so that the volume of air drawn through the receivers in the experiments was 428 cubic centimetres per stroke of the pump. This agrees with the measured effective volume of the two cylinders of the pump.

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TABLE I.—Results Obtained by the Introduction of Electrical Motive Power on the West End Street Railway, Boston, Massachusetts, U.S.A.

To September 30 of ...	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Total miles of track	—	233·24	234·69	244·00	259·80	268·33	272·89
Miles electrically equipped	—	—	65·46	81·23	148·04	182·50	212·47 (*f*)
Number of horse cars	1,584	1,794	1,694	1,662	1,226	826	606
Number of electric cars	—	47	337	469 (*a*)	1,028	1,346	1,509 (*g*)
Total revenue miles run	15,431,758	16,573,831	17,665,360	17,462,572 *b*)	17,498,660 (*c*)	18,669,809 (*d*)	19,240,486 (*e*)
Electric revenue miles	—	—	—	4,588,186	9,622,000	14,189,054	16,794,961
Percentage of expenses to earnings	82	82	77	74·4	70·8	68	66·44
Investment of electrics	—	£85,270	£312,132	—	£1,188,890	£1,572,334	—

(*a*) The long cars introduced at this time, and now almost exclusively used on the company's electric lines, are almost twice the size of the regular two-horse car. (*b*) Electric mileage, 26·27 per cent.; horse mileage, 73·73 per cent. (*c*) Electric mileage, 48·63 per cent.; horse mileage, 51·37 per cent. (*d*) Electric mileage, 76·17 per cent.; horse mileage, 21·83 per cent. (*e*) Electric mileage, 87·29 per cent.; horse mileage, 12·71 per cent. (*f*) And 25 additional miles partially electrically equipped. (*g*) And 103 electric snow-ploughs. Population of Boston, 1890, 448,477.

gas flame or an electric current. When the tube was cold, and non-electrified air drawn through it, we found no signs of electrification by our receiver and electrometer. But when the tube was made red or white hot, either by gas burners applied externally or by an electric current through the metal of the tube, the previous non-electrified air drawn through it was found to be electrified strongly positive. To get complete command of the temperature, we passed a measured electric current through 20cm. of the platinum tube. On increasing the current till the tube began to be at a scarcely visible dull red heat, we found but little electrification of the air. When the tube was a little warmer, so as to be quite visibly red hot, large electrification became manifest. Thus 60 strokes of the air-pump gave 45 scale divisions on the electrometer when the tube was dull red, and 395 scale divisions (seven volts) when it was a bright red (produced by a current of 36 amperes). With stronger currents, raising the tube to white-hot temperature, the electrification seemed to be considerably less.

THE MODERN APPLICATION OF ELECTRICITY TO TRACTION PURPOSES.*

BY PHILIP DAWSON.

The history of electric traction extends over a period of well-nigh half a century. As in the case of most similar developments of applied science, that history is largely a record of disappointment and failure of tests which promised much from a theoretical standpoint, but which wholly failed to demonstrate any probable practical value.

The self-contained car carrying a sufficient store of energy for a given period of operation was long the only idea of the inventor. The first radical departure was made by Siemens at the Paris Exhibition of 1878, where a stationary generating plant furnished power to the motors on the cars, the rails serving as the connecting medium. This, and the success achieved by the cable tramway, turned the tide of experimentation toward the evolution of a workable system of sub-service conductors. It was not, however, until 1884, when the overhead conductor was introduced, that any really efficient and practical solution of the problem seemed possible, and the succeeding four years were devoted to the elaboration of the many details connected therewith, and to the development of a type of apparatus which electrically and mechanically could withstand the excessive strains inseparable from tramway service.

It may be safely said that electric traction, as we to-day understand it, dates back no longer than 1888. That it should then have received, with all its imperfections, some measure of acceptance, is wholly due to the absolute necessity which existed in the United States for increased facilities of rapid transit. The horse tramway had failed to fill the demand—the introduction of cable could only be contemplated where a great passenger traffic was assured beyond question—the steam tramway was heartily disliked by one and all. One great company (the West End Street Railway of Boston), having an enormous interest in the development of suburban residential property, which could not be efficiently served by any accepted means of traction, took the bull by the horns and decided (and widely published) that it was prepared to investigate the question as to whether any new system of traction could meet its pressing needs and to adopt that one which could demonstrate success. The opportunity so offered, under conditions which assured experienced judges, a fair field, and a great reward for the successful competitor, was eagerly availed of. The modern history of electrical motive power begins with that competition. The result to the pioneer company can best be expressed in tabular form (Table I.).

We see that the decrease in the percentage of working expenses to gross receipts has varied almost directly in proportion to the introduction of electric plant. In 1888-9, before electricity was introduced, the percentage of expenses to earnings was 82 per cent. In 1890, as soon as the first outlying lines were electrically in operation, the percentage decreased to 77 per cent. In 1891, over one-fourth of the car mileage being electrical, the percentage is again decreased to 74·4 per cent. In 1892, with nearly one-half of the total mileage run by motor cars, the percentage drops to 70·8 per cent. In 1893, over three-fourths of the entire system having been electrically equipped, we find the ratio of expenses to earnings only 68 per cent., and the statistics of 1894 show the present operating expenses to be 66·44 per cent. of the gross receipts. This reduction has been made, notwithstanding the fact that the additional investment required for electrical plant and apparatus had to be provided for, and that such part of the former rolling-stock, buildings, horses, etc., as was rendered useless or disposed of at a loss, had to be written off. Moreover, the introduction of heavy motor cars, and of a service higher in speed, required that the permanent way should be reconstructed in many places, and much heavier metals employed. The results obtained in the whole State, of which Boston is the capital, are equally satisfactory (Table II.).

Table II.—Results obtained by the Introduction of Electrical Motive Power on the Street Railways of the State of Massachusetts (pop. 1890, 2,238,943).
(From the report of the Railway Commissioners of the State.)

	1888.	1894.
Total mileage of track	533·59	929
Mileage of track electrically equipped	nil	825
Total number of car miles run	23,244,767	36,722,978
Total number of passengers carried	134,478,319	220,464,099
Net earnings per car mile run, in pence	2·8	4·7
Percentage of operating expenses to gross income	81·07	69·5

These are the results obtained in but a single one of the United States, and that by no means the largest. It may incidentally be said, however, that no city in the Union is more English in type than Boston, and no State more closely resembles England than Massachusetts both from a social and commercial aspect.

It is interesting to note from the "Tramway Manual," 1894, that the total tramway mileage of Great Britain is 960 miles; the number of passengers carried in the year, 598,289,509; and the ratio of expenses to receipts 78·7 per cent.

Table III.—Progress of Electric, Horse, and Cable Lines in America, 1890 to July, 1895.

Street railways.	1890.	1891.	1892.	1893.	1894.	July,'95.
Mileage total	9,037	10,599	11,665	12,186	12,527	14,020
,, electric.	2,523	4,061	5,939	7,466	9,008	10,752
,, horse	5 400	5,302	4,460	3,497	2,243	1,957
,, cable	510	594	646	657	662	632
,, steam	—	—	—	—	—	—
and various	604	642	620	566	614	679
No. of cars—total	32,108	35 877	37,399	40,499	41,668	45,756
,, electric	5,592	8 892	13,415	18,233	24,849	35,004
,, horse	21,970	21,798	19,315	16,845	11,507	6,438
,, cable	3,795	4,372	3,971	4,805	4,673	2,080
,, steam	—	—	—	—	—	—
and various	751	815	698	616	639	*2,234

* Including cars towed by motor cars.

Within the first six months of the Boston trials accumulator

* Paper read at the meeting of the British Association at Ipswich.

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cars and conduit-contained conductors were hopelessly out of the race. The trolley wire and wheel had demonstrated an overwhelming superiority. The new system of mechanical traction was accepted throughout America, and the subjoined Table III. shows with what amazing rapidity.

(To be continued.)

STORAGE BATTERIES.*

BY H. A. EARLE.

When I undertook to read a paper before this association I hoped that I might have been able to treat the subject in a more exhaustive manner. The time at my disposal has, however, been limited, and the subject is one of such magnitude, and the results under different conditions of test so numerous, that I have found it impossible to do more than give a general outline from a practical point of view. It is interesting to trace the history of storage battery manufacture, and by so doing each step in the advance up to the present time can best be considered.

The discovery of secondary currents dates back to 1801, when Gautherot found that silver or platinum wires, which had been used to decompose a saline solution, were capable of giving a reverse current of short duration. Ritter, in 1803, was, however, the first to make a secondary battery, in which he employed plates of gold separated by cloth or paper, the same being moistened with a saline solution. He experimented with various metals, including lead, but the secondary currents obtained were of short duration, and the batteries only of scientific interest. It appears at first sight strange that Ritter, when using lead, obtained no increased effects, this being the metal exclusively employed at this time. He, however, used salt water, and this formed chloride of lead, scarcely soluble, and a very bad conductor; on this account the current was very weak in comparison with that which would have been obtained if water acidulated with sulphuric acid had been used. Since that time many scientists have investigated the subject, and De la Rive in 1826 obtained secondary currents from platinum plates in a voltameter filled with water and sulphuric acid; and he closely approached the elements of our present storage battery when, among his many experiments, he used in a primary battery a platinum plate covered with a film of peroxide of lead and a zinc plate immersed in an acid solution. The first powerful storage battery was introduced in 1860, when Planté constructed cells composed of lead plates immersed in an acid solution of 1·068 specific gravity (10 per cent. acid); these were a success with the exception that the method employed for their formation—namely, frequent charges, discharges, reversal of charge, and periods of rest—was too long and expensive for practical purposes, several months being necessary to obtain a useful capacity.

The subsequent rapid development and improvements in electrical machinery and lamps created a real demand for a good storage battery, and turned the thoughts of many to the subject, and the next and one of the most important of subsequent improvements was that introduced by Faure in 1881—namely, of pasting a coating of lead oxide on the surface of the plates, which rendered them, after a comparatively short formation, ready for use. The Faure cell was never, however, as originally designed, a practical success, for though the active material was encased in a covering of flannel or felt, the pasted coating, being on upright surfaces and having insufficient adherence, came away within a period not sufficiently long to give economical results. Swan realised that the active material required a better mechanical support, and introduced a plate of grid form, the interstices serving to retain the material. This frame, combined with the Faure pasting, was the origin of the plate that has been largely used in this country and elsewhere. Up to the date of the expiration of the Swan and Faure patents the manufacture of pasted plates in this country was in the hands of one company and its licensees, and competition was thereby to a great extent absent. This is, however, more likely to have been an advantage than otherwise, for much has meanwhile been done to perfect and cheapen the production of the solid lead plates, and these are making such strides forward that it seems probable they will eventually outstrip and replace their pasted rivals. Solid plates have been made of various types, and some have been pasted to avoid the expense of formation, the paste in this case serving to give the required capacity till the action of charging and discharging gradually attacked the solid surface. Improved methods have, however, been discovered for effecting rapid formation at a reasonable cost, and although pasting is now open to all, in all probability there will be little extension of its use, unless means are devised for the better retention of the material. Another type which differs greatly from the solid lead plate, but which is not pasted, is the chloride plate. In this case the material to become active is a mixture of chloride of lead and chloride of zinc, which is cast into small tablets, these being framed by casting antimonious lead around them under high pressure. The subsequent elimination of the chlorine and zinc leaves a porous structure of pure lead of a crystalline nature, good conductivity, and with a large surface exposed to the electrolyte, the result being a large capacity for a given weight and for the space occupied.

The mere manufacture of an accumulator with lead and sulphuric acid is a simple matter, but when combined with the necessary requirements of low first cost for a given capacity and long life it presents more difficulties than is perhaps generally supposed. Omitting the question of cost, the chief points to be considered are the chemical action, the mechanical construction, and the proper treatment of the cell when made. In lead batteries the minimum weight is limited by the chemical requirements. The theoretical value of lead peroxide is 4·44 grammes per ampere-hour, or, roughly, 1lb. is the equivalent of 100 ampere-hours. Presuming that the positive and negative plates are identical, the value would be approximately 50 ampere-hours for 1lb. of peroxide and spongy lead. As a matter of fact, the highest-capacity plates yield only about seven ampere-hours per pound of positive and negative plates, or 16 ampere-hours per pound of peroxide and spongy lead, due to the facts that a conducting frame of considerable weight has to be employed, and to the impossibility in practical working of reducing the whole of the peroxide. To obtain the best results for a given weight, the frame must be reduced to a minimum consistent with the necessary strength and conductivity, and the distribution of the peroxide must be such as to admit of the perfect circulation of the electrolyte and its penetration throughout the mass. When the active material is retained in holes or interstices, due provision must be made for its expansion on oxidation, for the power exerted is so great that it will bend or burst a frame which holds it too tightly. Various methods have been adopted to prevent buckling, but it is still a source of trouble with perforated pasted plates. Solid grooved or ribbed plates, however, the grooves on which are filled with paste, are not subject to the same extent to this fault; solid plates, on which the active material is formed out of the substance of the plate itself, are practically free from it. In the chloride plate ample provision is made for this increase in volume by the elimination of the chlorine and zinc, which renders the structure porous and cellular.

Nothing is more interesting than the behaviour of cells under various conditions, and from the innumerable curves that can be plotted we can readily study the effects due to different rates of charge and discharge, to the penetration and strength of the electricity, and to the ratio of the positive and negative plates. From these and many other similar tests much useful information can be obtained for guidance both in manufacture and treatment. There is a given rate of charge for every type of cell which is most suitable, not only for its efficiency, but also for its durability. With some types a high rate is quite inadmissible, and a period of 10 hours is required; other types, however, are of such a construction that they may be fully charged in four hours without detriment. This variation is mainly due to the disposition of the active material, to its thickness, and to the method of its production—namely, whether it has been mechanically applied or electrolytically produced. Most of the effects of varying rates of charge can be ascertained from the resultant discharge, but discharge curves have nevertheless characteristics of their own which are to a great extent unconnected with the conditions of charge, and they depend upon the type of plate, strength of acid, the rate of discharge, and other influences.

A series of curves is exhibited (Fig. 1), and these give at a glance results obtained with plates of various manufacture; in every instance the weight of one positive and one negative has been taken. Knowledge of the ratio of weight of active material to frame is naturally necessary for the complete investigation of these curves, but in this case the weight of the plates themselves has only been taken into consideration, as it is merely intended to show results obtained from various types of plates at present manufactured. Curve A is taken from plates, the active material on which is of a very porous and cellular nature, of 5-16in. thick. It will be noticed that the capacity per pound of plate continues to rise up to the 12-hour rate, and that at that point is still slightly on the increase. This increase is, no doubt, partly due to the gradual penetration of the acid, and partly to the rapid sulphation of the surface at the higher rates. Curve B is that given by a positive plate, the active material on which is distributed in a thin layer over a very large surface, the negatives being the same as employed for Curve A. This plate gives less ampere-hours per pound of plate, owing to its possessing a heavy frame, but per pound of peroxide of lead its yield is greater; the active material in this plate is not formed out of the substance of the frame, but is entirely independent of it. A plate of this description, in which the whole face of the active material is directly exposed to the electrolyte, is capable of giving its maximum capacity at a comparatively high rate of

* Paper read at the meeting of the British Association at Ipswich.

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discharge. A thin layer of peroxide spread over a large surface reduces the clogging of the surfaces to a minimum, and a free circulation of the electrolyte admits of fresh acid of the proper specific gravity being continually available. Curve C is obtained from a pasted plate suitable for slow rates of discharge, and from its rise in capacity at reduced rates we notice somewhat similar characteristics to that in Curve A. There is, however, a remarkable point of difference between Curves A and C, for the plates in each instance contain approximately 30 per cent by weight of active material; Curve A, therefore, gives us about double the ampere-hour yield per pound of active material over Curve C, and this is obtained by

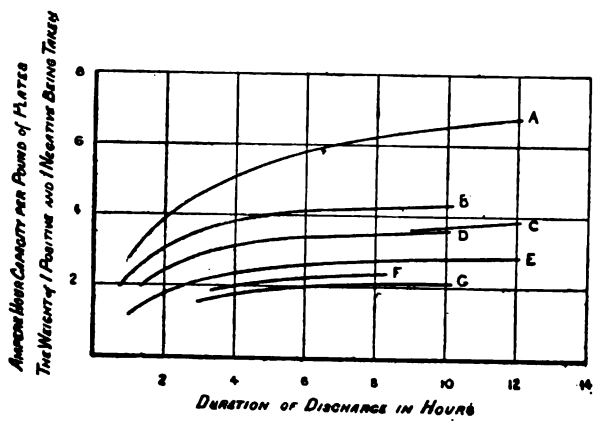

FIG. 1.

the cellular and porous structure of the material in the A-curve plate. Curve D is taken from plates cast with ribs on their surfaces, the active material being formed out of the substance of the plates themselves; the curve is very similar to B, but falls lower on the scale, this being caused by the weight of the positive plate, its thickness being considerable in order to give a reserve of metal, which in its turn is acted upon as the plate gradually disintegrates. Curve E is given by plates, the surfaces and interior being full of blowholes, which give a large exposed area; their weight for a given output is, however, large. Curve F is a pasted plate with a solid frame, which gives a poor return for its weight; in this curve we notice the rise in capacity at reduced rates due to pasted plates. Curve G gives the capabilities of very heavy plates which are pasted on their surfaces, the paste being intended merely to give the required capacity till its disintegration, by which time the frame itself has been sufficiently formed to do the work; the rapid flattening of this curve indicates that the layer of paste is thin. The curve of voltage of a discharging cell varies greatly, and is dependent upon the rate of discharge, the strength of acid, the distance of plates apart, its curve of internal resistance, and the treatment it has been subjected to beforehand, besides many other interesting conditions.

Fig. 2 demonstrates the effect of varying rates; these curves have all been obtained from cells of the same type, the acid having been approximately 1·210 specific gravity when the cell was fully charged. Discharges at varying rates are given—namely, 1, 2½, 3½, 5½, and 7½ hours—and though slightly different results would be obtained with other types of cells, they may be taken at a fair approximation for general reference.

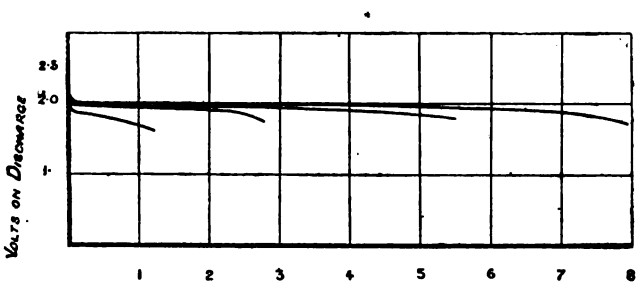

FIG. 2.

When considering the question of fall in volts on discharges at different rates, it will not be out of place to draw attention to conditions that are frequently given in specifications for storage batteries; in some instances a fall in volts not exceeding 8, 10, or 12 per cent. is allowed, and the rate in amperes and the time in hours for which the discharge is to be maintained are stated. This is in most instances unsatisfactory, for what are we to take as our starting point? The E.M.F. on open circuit immediately after complete charge is practically a fixed value, with a given type of cell and a known strength of acid. But the fall in the first few minutes varies greatly according to the rates of discharge, and at high rates it may fall as much as 10 per cent. in a few minutes, or even seconds, before a comparatively straight line has been reached and the cell is working at its normal voltage for the specified rate of discharge; this is quite clear by reference to Fig. 2. Another point to which our attention is drawn is the fall of voltage on open circuit after the completion of charge. A series of curves (Fig. 3) are exhibited showing the fall in voltage for a period of 21 hours, each curve being for a different strength of acid; it is therefore evident that if a given percentage of fall is allowed it will be most advantageous for the manufacturer, but not for the purchaser, to allow the battery to stand for a few hours in order that this useless high voltage be reduced. The best way to meet this point is, however, to take the first reading of voltage five or ten minutes after the discharge has commenced. In other specifications the voltage is fixed to a hundredth of a volt, and the cell must give the specified capacity above this limit. In many instances, and especially when high discharge rates are specified, the voltage given is much too high on the curve, and in some instances I have found it actually fall on a straight portion of the same, so that the time at which this point is passed raises an unpleasant difference of opinion between the buyer and the seller. This class of specification generally necessitates a very much larger battery than was intended, with corresponding increased cost; and should the manufacturer not have been exceedingly careful in preparing his estimate, he may find that the buyer is not satisfied with a good excess of ampere-hours, but will have his volts as well, even if this means 50 per cent. in ampere-hours in excess of what he thought he was ordering.

There are many ways in which a specification can be framed so that a battery of the exact size required is obtained, and there is no doubt that it is most satisfactory to all concerned if the exact capacity in ampere-hours is specified, and the final voltage of the complete battery at a given rate, the number of cells being omitted. Under these conditions, if the individual cells are discharged down to a low voltage, more cells would be required, but each additional cell on a 100-volt circuit adds 2 per cent. to their number, and correspondingly increases the

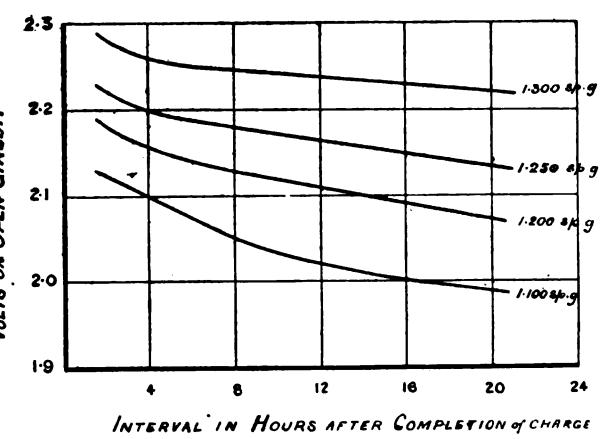

FIG. 3.

cost of a battery composed of cells of a given size. On the other hand, a low voltage per cell on discharge enables, up to a given limit, the number of plates per cell to be reduced, and the cost of cell as well. In a competitive tender the manufacturer would therefore work out the cheapest arrangement, and I find that this would not admit of the individual cells being discharged to too low a voltage, and that the purchaser would obtain exactly what he required at the lowest price. The actual number of regulator cells is of small moment to the user, and the additional number required when the individual cells are discharged down to a voltage of 1·8 in place of, say, 1·9, is only two in a 100-volt battery.

When tests are made to check the efficiency and capacity of a battery, we can place no reliance on the figures obtained from a single charge or discharge. As a rule, no two consecutive discharges from a cell are identical even when the same is discharged with the same current, and down to the same voltage, every discharge being greatly influenced by the previous treatment. Table A, given herewith, clearly demonstrates this. This table is in no way intended to be a guide as to what can be obtained in efficiency tests, but is merely to show the irregular nature of results obtained with slight variations in time and maximum voltage of charge; the rated capacity of the cell was 15 amperes for 10 hours, or 150 ampere-hours. Charge No. 1 we can omit, as this was given to complete the formation of the cell. Charge No. 2 was for a similar purpose. Charge No. 3 was continued, as were also charges 1 and 2, till the voltage had practically ceased to rise; a high voltage on charge gives a good return in ampere-hours on the discharge, but if a cell is forced to its maximum capacity we obtain a poor return in efficiency. Charge and discharge No. 4 are very similar to No. 3. Charge No. 5 was stopped when the E.M.F. had risen to 2·5 volts, and 30 per cent. less ampere-hours had

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TABLE A.

Charge No.	Charge: Duration of charge.	Charge: Rate in amperes.	Charge: Volts at end of charge.	Charge: Ampere-hours.	Charge: Watt hours.	Discharge No.	Discharge: Duration of discharge.	Discharge: Rate in amperes.	Discharge: Volts at end of discharge.	Discharge: Ampere-hours.	Discharge: Watt-hours.	Percentage of efficiency: Ampere-hours.	Percentage of efficiency: Watt-hours.
	Hrs. Min.						Hrs. Min.						
1	3 00	15	2·68	45	—	1	7 30	15	1·68	113	218	—	—
2	9 45	,,	2 68	146	—	2	7 45	,,	1·70	116	227	79·4	—
3	12 00	,,	2 68	180	428	3	9 25	,,	1·70	141	278	78·3	64 9
4	12 30	,,	2 67	187	443	4	9 50	,,	1·70	148	285	79·1	64·3
5	8 45	,,	2·50	131	299	5	8 40	,,	1·70	130	255	99 2	85·3
6	11 15	,,	2 40	169	399	6	9 35	,,	1 91	144	274	85·2	68 7
7	11 15	,,	2·38	169	398	7	9 32	,,	1·915	143	276	85 2	69 3
8	10 35	,,	2·136	159	324	8	9 15	,,	1·90	139	273	87·4	84·2
9	10 35	,,	2 333	159	375	9	9 10	,,	1 90	138	264	87·4	70·4
10	10 15	,,	2 333	154	361	10	9 00	,,	1·90	135	265	87·6	73·4

passed through the cell. Studying the figures up to the end of charge 5, it would have been practically impossible to assume what was going to happen on discharge No. 5; on taking this discharge we obtain 20 per cent. increase both in ampere-hour and watt-hour efficiency, and the very high percentage of the former—namely, 99·2 per cent.—points to the fact that peroxide, which had been previously inactive, was reduced. The first five discharges you will note were all taken down to 1·70 volts; this cell had never been used before, so we have its history up to the tenth discharge in the table—the strength of acid at end of charge was practically 1·300 specific in every instance. Charge No. 6 was only continued to 2·40 volts, but it required 2½ hours' longer charge to reach this voltage than it previously did on charge 5 to reach 2·5 volts, and this was without doubt due to the good service rendered on the last discharge. The remaining charges and discharges show that the highest efficiencies are obtained when the cell is not charged up to a high voltage, and if worked within reasonable limits 90 per cent. in ampere-hours and about 80 per cent. in watt-hours can be obtained with the cell in question, when in good order.

Usually, efficiency is not of great importance, for, presuming a central-station battery to give one-tenth of the total supply, a variation of even 10 per cent. in efficiency would only represent

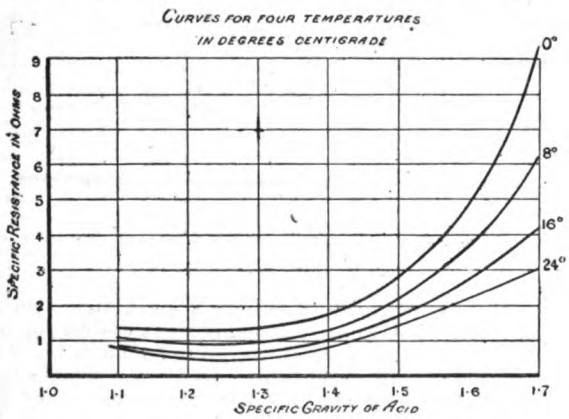

Fig. 4.

1 per cent. variation in the total output; but the time may come when batteries are so cheapened and perfected that they supply the whole demand of our station, and their efficiency will then be one of importance, and we may be confronted with specifications as strict as those now framed for dynamos.

The strength of acid solution to be used in a cell is an important point. In the first place, this greatly influences the voltage, as we have seen from Fig. 3; it has also a great effect upon the life. Besides this, in strong acid the plates sulphate more readily, and the sulphate is more difficult to reduce; it is therefore necessary to carry out most careful tests to ascertain what strength of acid should be used in each type of cell. The resistance of acid solutions of different strengths is also a most important consideration, and on Fig. 4 four curves are shown, giving its resistance at 0, 8, 16, and 24 degrees C. Taking 16deg. C. as a mean working temperature, it will be noted that acid of about 1·250 specific gravity has the least resistance, and it might be assumed, therefore, that this was the best strength to work at; but we must bear in mind that this strength does not give us the highest voltage, and, moreover, the gravity gradually falls as the cells discharges, and when working with this strength we have falling voltage on discharge, and at the same time increasing resistance of the electrolyte. No fixed law can be laid down, as each type of cell requires a given strength for best results.

Immediately upon commencing our research with a view to ascertain the proper strength of acid, we find that we are confronted with another problem of great interest, which is, that different strengths give us different capacities from our cell. Fig. 5 gives two most interesting and instructive curves taken from two cells of the chloride type—one with positive and negative plates of ·24 of an inch thick, Curve A, and one with positive and negative plates of ·4 of an inch thick, Curve B. Each cell was discharged at a rate equal to ·45 of an ampere per pound of plate. The rate per pound of active material is nearly the same for each cell, though perhaps slightly higher for the thinner plates. The rate of discharge per superficial area was therefore approximately 40 per cent. greater with the thick plates than with the thin. The curves give the yield in ampere-hours per pound of active material with different strengths of acid. Considering the thin-plate curve first, we find that with acid of 1·070 we do not obtain more than about 3 per cent. of the maximum

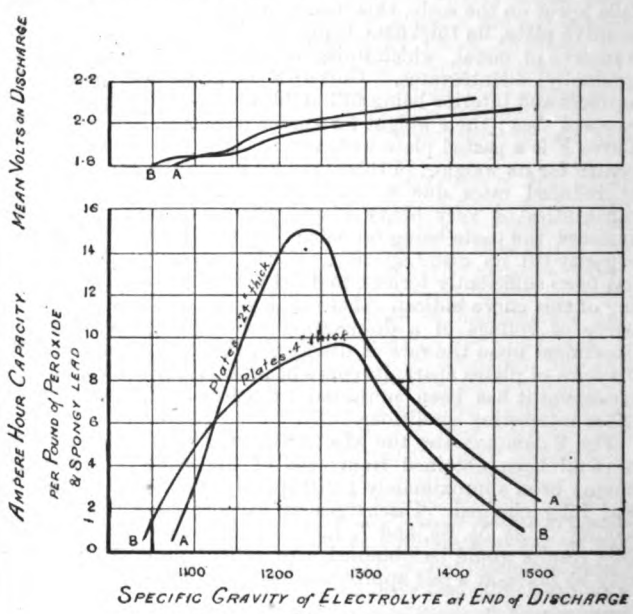

Fig. 5.

capacity; from this point to 1·230, at which point we obtain the maximum capacity, it rises very rapidly, each addition of 1 per cent. to the sulphuric acid present in the electrolyte giving an increase of about one ampere-hour capacity per pound of peroxide; from 1·230 to 1·500 it falls as rapidly almost as it rose, and at the latter figure we obtain only 16 per cent. of the maximum. Taking the thick-plate curve: at 1·040 specific gravity we obtain about 6 per cent. of the maximum capacity, and it rises till 1·270 is reached; it then falls rapidly, and at 1·500 the output is practically nil.

Considering these two curves, we note that the thin plates give as a maximum 15 amperes per pound of peroxide and spongy lead, or 30 ampere-hours per pound of peroxide alone, or about one-third of the theoretical value. The thick plates, on the other hand, give 10 ampere-hours per pound of peroxide and spongy lead, or 20 ampere-hours per pound of peroxide alone, or about one-fifth of the theoretical value.

The natural question is, why is this the case? also, why are the thick plates the best with very weak acid? and, who do they give such a much poorer return with acid of the strength usually employed? I consider that, up to the point at which the curves cross, that the better result obtained from the thick plates is due to the fact that, on completion of the charge in weak acid, the active material is saturated with strong acid, and the quantity contained in the same would be greater with the thick plates than with the thin, and they would therefore give

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a better output with weak acid than the thin plates. Their increased thickness, however, is of no advantage with acid of the ordinary strength when out-capacity is chiefly dependent upon the penetration of the acid. If we study the portion of the thick-plate curve between 1·150 and 1·400 specific gravity and compare it with the thin-plate curve, we find that the capacity is practically reduced inversely as the thickness or weight of the plate and the rate of discharge per superficial area. Quite apart from the question of the proper thickness of the active material, we see at a glance that very different capacities are obtained with different strengths of acid. On the top of the same figure the mean volts during the discharge are given; these, it will be seen, rise steadily as the strength of the acid is increased. A striking feature is that the curves of voltage cross at the same point that the curves of capacity cross. Upon consideration, we come to the conclusion that this is what would be expected, as the rate in amperes on discharge was the same in every case, and an increase in ampere-hours per pound of material means a longer time to complete the discharge, and we see from Fig. 2 that the greater the length of the discharge the higher the mean voltage.

It is the manufacturer's business to make as good a cell as possible, but when it leaves his hands it is judged by the service it renders during its life. This depends to a very great extent upon the treatment it receives. In the first instance, purity of the electrolyte is essential. Brimstone acid should be used, as this is the least likely to contain foreign substances. If this is diluted on the spot, the water must be pure—preferably rain or, if possible, condensed water. With regard to the first charge of the battery, it is generally imperatively stated that this must commence immediately upon the acid being put into the cells. This is no doubt necessary with imperfectly-formed pasted plates, or with plates which have been for some time exposed to the air, as they would readily sulphate, and require considerable time to reduce, but positive plates which have been fully formed, and negatives in good condition, are very slightly affected.

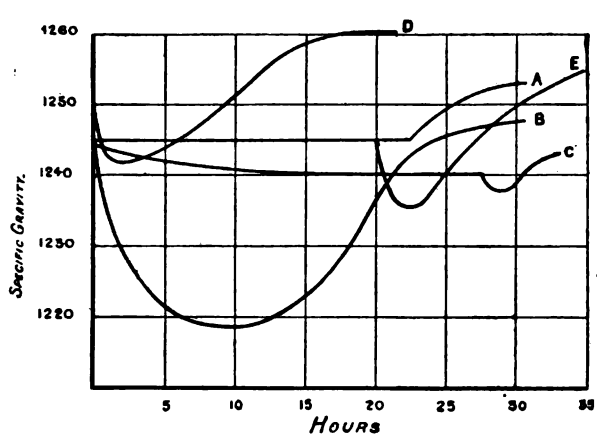

Fig. 6.

Fig. 6 gives five curves which I have prepared in order to show results obtained from plates in different conditions; some having been left standing in the acid while others were charged. Curve A shows the specific gravity of the acid in the cell in which the plates were allowed to stand for 22½ hours without being charged. During this period it remained absolutely constant, sulphation was therefore absent; the charge was then commenced and continued for eight hours: a rise in specific gravity took place, raising the electrolyte to a gravity above that at which it was put into the cell, which showed that sulphate was previously present in the plates. Curve B shows what happened in another identical cell—directly the charging current was started the gravity fell rapidly; this, I presume, is due to the formation of oxide of lead from the pure lead remaining in the active material, and this is sulphated before becoming peroxide of lead. The current throughout the charge was kept constant, and from the curve we see that practically the same number of ampere-hours were expended during the fall as during the rise; the specific gravity in this instance also rose slightly above its initial value. The plates in Curve C, which had been standing, sulphated slightly, and reproduced, on being charged, to a small extent a similar curve to B, and the plates (Curve D) which were charged at once give a very small fall but a considerable rise, showing that sulphate was present in the plates. Curve E is for plates which stood before being charged, and in this instance we notice that no sulphation took place, and that they gave a small fall and rise. My chief object in giving these curves is to demonstrate how very slight differences can give considerable variations.

To return again to the treatment of cells: the chief causes of destruction are too prolonged or excessive rates of discharge, insufficient charging, overcharging, long periods of rest on open circuit without charging, and allowing cells to remain after complete discharge for many hours before recharging. There is also another point worth mentioning. Frequently, through under-charge or over-discharge, the plates become heavily sulphated, the cells no longer give their proper output, and the specific gravity of the electrolyte falls considerably. Of course a prolonged charge will put this right, but frequently it is assumed that, as the specific gravity is low, the acid merely requires strengthening, and this is done with the best intentions; the fault is, however, aggravated, and the plates sulphate more heavily than before. I found on one occasion that acid had been periodically added, and the specific gravity rigidly maintained at 1·200, the charge being always stopped when this strength was reached. The cells were naturally working very badly. A prolonged charge was accordingly given, and this raised the strength of the electrolyte as high as 1·450 in some cells, which was a clear indication of what had been done. We find, therefore, that a multitude of causes influence the working and life of storage batteries, and that many of these can be varied at will; the problem, therefore, is to so combine all useful effects that we produce the best possible article with due consideration to low cost.

It would be a natural question to ask, What do you consider the best possible article? and this is easily answered. In a secondary battery we have lead, sulphuric acid solution, and the resultant compounds, and nothing else. The ideal cell is one that is indestructible, and this being given, the first cost and weight, if kept within reasonable limits, are of little moment. At the present moment the life of a cell is its value, and all types are constructed with the knowledge of certain death; and in most types this lingering death is provided for, for we find at the bottom of the boxes a sufficient space to act as a receptacle for the deposit from the disintegrating plates. In other types, where the active material is held permanently in position, disintegration still goes on, with consequent loss of contact. Now, this disintegration is what we have to stop. The deposited disintegrated material is as good as ever, for nothing is wasted; and provided it were held in perpetual, firm, and good electrical contact with the frame in such a manner that the free circulation and penetration of the acid were not hindered, and the internal resistance were not unduly increased, we should have produced an ideal and indestructible cell.

I have brought to your notice only a very few of the many interesting features in connection with secondary batteries, and these only in a most superficial manner. I have, however, endeavoured to give a general outline of results obtained in practice, and have not entered into a discussion upon other more serious questions. Many conjectures arise in one's mind when considering the causes of different effects, and each point requires much time and study in order that a fixed law may be deduced from the results obtained; and again the results of tests are often so conflicting, and depend so much upon very small differences of condition, that it is by no means an easy matter to arrive at the truth.

THE HERMITE PROCESS OF DEODORISING SEWAGE.*

BY J NAPIER, F.C.S., F.I.C., ETC., BOROUGH AND COUNTY ANALYST.

The treatment of sewage for the purpose of preventing putrefaction is a subject which has occupied the minds of chemical and sanitary engineers for many years, and numerous methods of dealing with it have been devised and brought before this and other societies, each claiming to perform its work in a more perfect manner than its predecessor. Those methods, with only one or two exceptions, treat the sewage at a point between the last inlet into the main sewer and the outfall, usually at the outfall, and as far away from the town as it is possible to put it. Those systems of dealing with sewage at the outfall do not give the town from whence it came any sanitary benefit. They do not prevent sewer gas accumulating in the sewers and escaping into the air from manholes or ventilating shafts and becoming an annoyance and nuisance to the inhabitants. The objects of those systems of treating sewage, then, is to purify the sewage sufficiently to prevent the pollution of a waterway or river, and without in any way being of the slightest benefit to the health of the town. With the Hermite process the sewage is treated at the other end of the sewers—*i.e.*, at the beginning—deodorised there, so that flowing through a town the sewers give off no offensive smells, and the putrefactive changes which take place in sewage have been arrested. With this system, then, there is no need for ventilating shafts, and if the manholes are perforated there is no offensive smell given off; on the contrary, there is a faint chlorous or bleach smell, which is much more acceptable to the nose than sewer gas. The principle of this process is passing a current of electricity through sea-water, or,

* Paper read at the meeting of the British Association at Ipswich

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if sea-water is not handy a solution of magnesium and sodium chlorides; a portion of these chlorides is converted into hypochlorite, a substance which disinfects, deodorises, and bleaches similar to the active ingredient of bleaching powder — calcium hypochlorite. The change from chloride to hypochlorite takes place almost entirely with the magnesium salt-yielding magnesium hypochlorite ($MgCl_2O_2$). It is found, however, that in the electrolysers and tanks a white deposit takes place, consisting of magnesium oxide combined with water—viz., magnesium hydrate—showing that the magnesium hypochlorite has decomposed, forming magnesic hydrate, which precipitates, leaving hypochlorous acid in solution. The action may take place as follows: $MgCl_2O_2 + 2H_2O = MgH_2O_2 + 2HClO$. This is called the Hermite solution. The amount of oxidising power is expressed by the quantity of available chlorine in grammes per litre—the usual working strengths being from five to one gramme per litre of solution. When sewage is mixed with about 5 per cent. of the gum solution, the offensive smell is instantaneously destroyed and the decomposition arrested for about six days, long enough under ordinary circumstances for the sewage to be well out to sea. I have not attempted to give a description of the electrolysers and their working: it would only be taking up valuable time. Those who are interested and will visit the installation in Constantine-road, will see the plant at work, and have all details explained. This electrolysed, or Hermite, solution has been subjected to many experiments, and numerous criticisms have been made upon it as to its power of rendering sewage sterile—as, for instance, the *Lancet* Commission, who report favourably on the system from experiments made at Worthing; also by Sir Henry Roscoe and Mr. J. Lunt, B.Sc., the results of which were read before the Society of Chemical Industry and described in that society's *Journal* in March last. Sir Henry found that a ·8 gramme solution practically sterilised the liquid portion of sewage, when used in sufficient quantity, and that the solid matters were unaffected. Well, a solution which will thus practically sterilise liquid sewage must, I think, be of great value, and when used in effective quantity tend to benefit any locality by preventing those contagious diseases which are usually developed from sewer gases. Although chemical and sanitary engineers have had this aim—*i.e.*, to completely sterilise sewage—in view, this point has not been attained on the large scale by any of the at present known systems. Hermite solution, however, does the next best thing, for in larger proportions it sterilises the liquid portion, and even in small quantities completely deodorises. This is confirmed by Sir Henry Roscoe's eleventh conclusion—viz., "the Hermite fluid even of ·25 strength acts as an excellent deodoriser." This is the point taken up by the Ipswich Corporation. They say, if we can have the sewage deodorised and its decomposition arrested for from three to six days the sewage will be well out to sea, and the nuisances of offensive smells in the town will be entirely done away with. Sir Henry also made experiments as to the stability of the electrolysed solution, and he found that a ·5-gramme solution lost 90 per cent. of its strength in 24 hours, a ·75-gramme solution being more stable, losing 34 per cent., and a 1-gramme solution 10 per cent. in the same time. This is very interesting and important, but as regards the working of the system in Ipswich, it is not necessary to take this into consideration, because the moment the electrolysed solution is made it is carried direct into the sewer within two minutes after its production. We have in Ipswich been electrolysing sea-water for three months and treating the sewage. The Sewage Committee directed me to report on its working, so I made daily tests and inspections for about two months. The strength of solution varied from half a gramme to one gramme, according to the flow of sea-water through the electrolysers, the quantity of available chlorine made being fairly constant, and the average being 1·04 gramme per ampere-hour. As to the effects of this solution on the sewage I have no figures to give you, but can give a general idea of its deodorising powers. I shall first draw your attention to a plan of the town of Ipswich, its situation with regard to the rivers, and the course of the sewage to the outfall. We have two rivers—viz., the Gipping, a canal which extends to and is navigable as far as Stowmarket, about 10 miles inland. The last or bottom lock is situated near Handford Bridge. Below this point the river is tidal, and is called the Orwell, which for beauty at high water is not to be excelled even by the Clyde or Rhine. In close proximity to the town we have the dock, covering about 33 acres, along each side of which the principal merchants of the town have their works or premises for shipment. The Gipping has an arm which leads from the locks to where there was once an oil-mill (now the steam laundry) driven by a waterwheel, and from this there was a waterway through the town as far as Fison's Mills at Stoke Bridge. When Ipswich was sewered, about 16 or 17 years ago, according to the suggestions of Mr. P. Bruff, and carried out by our present borough surveyor (Mr. E. Buckham), the main or intercepting sewer was laid in this waterway, from Portman-road, as far as it went, and continues to the outfall. The difficulties in the way of sewering and treating sewage in Ipswich may be explained in Mr. Buckham's own words: "To dispose of the sewage of Ipswich, either by irrigation or by intermittent filtration, would be attended with considerable expense. The town is divided by the River Orwell, and, as is frequently the case with towns so situated, the longitudinal falls are very slight, while the lateral falls are very great. The fall from the one end of the sewer to the other is only 8ft., so the flow is not very rapid, whilst, taking a section of the town laterally, there is plenty of fall, and, in consequence, a rapid current into the main sewer. On this account the experiments with the electrolysed solution were made on the main sewer, and at present the solution is running in the sewer at Handford-road in close proximity to the beginning of the main sewer. The result is complete deodorisation of the sewage throughout a long length of the sewer. For a distance of 700 yards free chlorine can be instantly detected by test papers, and for a distance of 1,760 yards the chlorous smell is perceptible, although insufficient to have any action on the test paper. Not only does the main sewer receive the arterials, but it receives the drainage of several slaughter-houses and breweries containing much organic matter. Below the point indicated (Church-street, St. Clement's) there is such a great increase in the quantity of sewage that the results were doubtful. On several occasions, however, samples taken from the outfall were without smell and kept two days, and in one instance it kept four days. If the amount of electrolysed solution, or its strength, could have been increased, the sewage at the outfall would certainly have been completely deodorised, if not sterilised. This is a point which I hope the Sewage Committee will aim at, and when putting the plant permanently into the new buildings that they will have sufficient electrolysers and power to produce enough fluid to deodorise all the sewage of Ipswich and have some to spare for flushing or washing infected areas. I noticed in some of my early morning inspections, when the flow of sewage was at its minimum, that the deposit in the sewer was bleached nearly white by the action of the electrolysed solution. This process has not been going long enough to allow me to obtain any statistics as to the health of the borough or the death-rate, compared with previous years and with other towns; but this I am sure of, that where the sewage has been treated no complaints have been received as to offensive smells. I am confident that any town that adopts this process, which will boldly erect plant to produce more than enough of the electrolysed solution, will be spending money well, and in time will feel the benefit by increased health of the inhabitants, and also by having a lower death-rate. This is what I have suggested Ipswich should do, so that in a year or two, when we are able to make comparisons, we will find a reduction in the death-rate. Such a result will make the process cheap at any price."

COMPANIES' MEETINGS AND REPORTS.

ROCKHAMPTON (QUEENSLAND) GAS AND COKE COMPANY, LIMITED.

In their report for the half-year ended June 30 last the directors state that the electrical operations of the Company show a profit of £303, 13s. 9d., from which has been paid £300 interest upon the whole of the Company's debentures, leaving an unappropriated balance of £3. 13s 9d. to the credit of the profit and loss account of this section of the Company's business. During the half-year some additions, improvements, etc., have been made to the gas plant and the electric lighting plant and buildings. Reference was made in their last report to the engagement in London of a new electrical engineer. The candidate selected from a very large number of applicants by the Company's agents, after careful scrutiny into his antecedents and past professional experience, was Mr. E. F. J. Hewlett, M.I.E.E, who has been connected for some years with large electrical firms in England.

PROFIT AND LOSS ACCOUNT ON ELECTRIC LIGHT OPERATIONS HALF-YEAR ENDED JUNE 30.

Dr.	£	s.	d.
Generating electric current	627	2	3
Advertising	7	6	7
Management, etc.	62	8	6
Printing	4	10	0
Interest	300	0	0
Public lamps	2	19	7
Stationery	12	16	10
Insurance	23	15	1
L. expenses	12	1	4
Balance	3	13	9
	£1,056	13	11

Cr.	£	s.	d.
Electric current sales	838	15	9
Sundries	44	3	6
E. L. fitting account	141	16	9
Interest	31	17	11
	£1,056	13	11

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BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

Directors: J. B. Braithwaite, jun., Esq. (of Messrs. Foster and Braithwaite), chairman; Arthur Ayres, Esq., M.I.C.E.; Aymor H. Sanderson, Esq; Colonel Frederick George Steuart; B. H Van Tromp, Esq; Edward Woods, Esq. (past-president of Institution of Civil Engineers). Joint managers: John S. Raworth, M.I.C E.; R. Percy Sellon, M.I.E.E.

Sixth annual report to be presented to the shareholders at the general meeting of the Company to be held at Cannon-street Hotel, London, E C., on September 23, 1895, at 12 noon:

The profit and loss account shows a gross profit of £37,858. 4s. 5d., after providing for bad and doubtful debts to the amount of £2,205 17s. 9d., and writing down the value of shares and debentures in other companies, as shown in the balance-sheet. After deducting from the gross profit, general charges, maintenance of buildings, plant and patents, staff bonuses under the Company's profit-sharing scheme, and interest on debenture stock, there remains a net balance of profit, after including the amount brought forward from last year, of £11,329. 12s. 8d. An interim dividend at the rate of 6 per cent. upon the preference shares, and at the rate of 5 per cent. upon the ordinary shares, has been already paid for the half-year ended December 31, 1894, amounting to £12,150. It will be seen that the net profit for the year, exclusive of the amount brought forward, is £7,541. 3s 8d. The preference shareholders have already received £5 400 of this amount by way of interim dividend as above, and they will be entitled to receive the balance of £2,141. 3s. 8d. before the ordinary shareholders receive further dividends. Whilst the directors regret this result of the year's operations, which shows a decrease of net profit as compared with last year of £19,739. 8s. 5d , they think it right to state that it is solely due to loss incurred during the second half of the Company's financial year in connection with the contract which the Company is carrying out for the City of London Electric Lighting Company, Limited, and arises out of differences between the two companies as to the obligations involved under the contract. The directors are glad to be able to state that these differences are now at an end, and work under the contract is being again proceeded with. During the year the sum of £2,646. 1s. 9d has been expended on capital account, upon extensions of buildings and plant at the Loughborough works, and new patents taken over by the Company. The Austrian business of the Company, carried on from the Vienna factory of Messrs. Kremenezky, Mayer, and Co., has yielded improved results during the past year, and is now established upon a thoroughly profitable basis. The Australasian branch, having its headquarters at Sydney, New South Wales, has also shown a satisfactory profit for the year ended April 30 last, and with the improving commercial prospects in the colonies, correspondingly favourable results from this branch of the Company's business may fairly be expected. The contract and installation department has been fully employed during the 12 months under review, and central electricity supply stations for the municipalities of Leicester and Worcester, and for the Dover Electricity Supply Company, have been equipped with the Company's electrical plant and opened during the year. The Loughborough works are at present fully engaged on orders, and sufficient work is in hand and in prospect to maintain them so for some time to come. In the electrical shops plant is in course of manufacture for the equipment of electricity supply stations in St. Luke's, Middlesex, the Wandsworth district, and for the lighting of Valetta and the Government works at Malta, for which an order has recently been received. The rolling-stock and car departments are engaged upon the construction of locomotives for the Beira Railway, of cars for the Rouen Electric Tramways Company, and other orders. The directors are pleased to report that they have made arrangements for the manufacture of a new high-speed enclosed engine of a novel and simple construction, the invention of the Company's joint manager and chief engineer, Mr. J. S. Raworth. There is at the present time a large demand for engines of this class. The new engine has been submitted to Prof. W. Cawthorne Unwin, F.R.S., and to Mr. W. H. Maw, M.I.M.E, copies of whose reports are enclosed. The bonus profit-sharing scheme introduced among the Company's staff and workmen two years ago is giving general satisfaction among the employés, and the directors are satisfied that the scheme is working well In order to provide capital to meet the large expansion of the Company's business which has taken place since the last issue of capital early in 1893, the directors have decided to make an issue of second 4½ per cent. debenture stock to the amount of £105,000, which will be allotted at par to the holders of preference and ordinary shares. The entire interest charge on the Company's debenture stock, including the £105,000 now to be issued, will then stand at £10,350 per annum. The average annual net profit (including debenture interest) for the past six years, since the Company was formed in 1889, amounts to £25,337. The stock will therefore be amply secured. The increase in the extent and volume of the Company's business, especially during the past few years, is largely due to the development in this country of municipal and private electricity supply from central stations, of which business the Company has been successful in securing a substantial share. The manufacture of steam-engines for electrical engineering purposes has also been undertaken during that period, and upwards of 35 000 h.p. have been sold. The Company are also giving close attention to electric traction and electric elevator work, in both of which directions an important development appears to be imminent. Mr. Edward Woods and Mr. A. Ayres are the directors who retire by rotation, and, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., also offer themselves for re-election.

Dr. Balance-sheet, June 30, 1895.

	£	s.	d.
Authorised capital	750,000	0	0
Capital issued—viz., 90,000 6 per cent. preference shares of £2 each, £180,000; and 90,000 ordinary shares of £3 each, £270 000	450,000	0	0
4½ per cent. perpetual debenture stock, secured by debentures charged on the undertaking	125,000	0	0
Sundry creditors, £33,389. 1s 2d.; and bills payable, £11,499 11s. 1d.	44,888	12	3
Loans and overdrafts from bankers (£62,400 against security)	78 097	18	10
Provision for depreciation on property, patents, and goodwill account	5,385	2	1
Profit and loss account—Balance as per last account £3,788 9 0			
Balance of profit and loss account... 7,541 3 8			
11 329 12 8			
Less interim dividend paid on preference and ordinary shares..... 12,150 0 0			
See *per contra* 820 7 4			
	£703 371	13	2

Note.—Contingent liability in respect of uncalled capital on shares in other companies and on bills receivable discounted, £5,547. 4s. 11d.

Cr.	£	s.	d.
Property, patents, and goodwill—as per last account	287,084	14	3
Additions to plant, £2,487. 16s. 9d; and expenditure on new patents, £158. 5s	2 646	1	9
	289,730	16	0
Deduct amortisation of lease	856	3	2
	288,874	12	10
Stock—goods in hand in process of manufacture, work in progress, and materials in London, at Loughborough, and other places	100,829	0	0
Sundry accounts, £141,092. 13s. 8d; and bills receivable, £339. 9s. 10d	141,432	3	6
Cash at call, at bankers, and in hand	3,910	11	0
Shares and debentures in other companies at cost, £62,219. 16s. 7d; less amounts written off, £983	61,236	16	7
Liquidators' balances and suspense accounts	1,963	0	5
Balance of foreign and colonial branches accounts—excess of assets over liabilities, £88,423. 15s. 2d; balance of items in transit, and of expenditure from dates of separate balance-sheets to June 30, 1895, and of development of the business not included above, £15 881. 6s. 4d	104,305	1	6
Balance of profit and loss account, as *per contra*	820	7	4
	£703,371	13	2

Profit and Loss Account, Year ended June 30, 1895.

Dr.	£	s.	d.
General charges—viz., directors' fees	2,000	0	0
Auditors' fees	105	0	0
Salaries	8,048	5	11
Law charges	314	2	5
Insurance	650	13	7
Postage, stationery, and printing	948	18	3
Rents, rates, and taxes	2,864	15	9
Advertising and London office expenses	2,095	5	1
	17,027	1	0
Further cost of removal to Loughborough	193	19	15
Maintenance of buildings and plant	2,708	2	2
,, ,, patents	104	8	8
Bank interest and commission	2,227	15	0
Interest on debenture stock, to June 30, 1895	5,625	0	0
Staff bonuses for year ended June 30, 1894	2,430	14	6
Balance, profit carried to balance-sheet	7,541	3	8
	£37,858	4	5

Cr.	£	s.	d.
Gross profit	37,858	4	5
	£37,858	4	5

Balance sheet of the Foreign and Colonial Branches, being the balances of the following accounts: Vienna (made up to December 31, 1894), Australia (made up to April 30, 1895).

Dr.	£	s.	d.
Creditors—Open accounts and bills payable	55 130	2	6
Unpaid balance of purchase price of land secured by mortgage	7,250	0	0
	62 380	2	6
Lamp reserve account	463	9	8
Balance of assets over liabilities transferred to general balance-sheet	88,423	15	2
	£151,267	7	4

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Cr.	£	s.	d.
Property—freehold and leasehold lands, buildings, plant, tools, fixtures, etc, at Vienna and in Australia	41,397	10	4
Stock—stores, goods in hand and in process of manufacture	50,189	19	11
Debtors—sundry accounts (after provision for doubtful debts) and bills receivable	55,608	8	5
Cash at bankers and in hand	3,359	16	2
Australian suspense items	711	12	6
	£151,267	7	4

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ashton-under-Lyne.—Tenders are invited for the supply of an electric light installation. Apply to Wagstaffe's Steam Preserve Works, Hurst Brook, Ashton-under-Lyne.

Tongres.—The Municipal Authorities of Tongres (Belgium) invite tenders by October 12, 1895, for the concession for the installation and working of the electric light in the town.

Alexandria.—The Municipal Authorities of Alexandria, Egypt, invite applications by October 1, 1895, for the concession of the tramway lines from St. Catherine Place, through the outer boulevards, to the projected abattoirs at Mex, with a branch line. Security £E1,000.

Southmolton (N. Devon).—The Southmolton Shirt and Collar Manufacturing Company, Limited, invite tenders for wiring the factory buildings for the electric light and ironing, including all the electric generating plant. The company find the power. Particulars of the Secretary, Southmolton, N. Devon.

Leeds.—Tenders are wanted for providing and fixing several new lightning conductors, and for repairing others, upon and at the workhouse premises in Beckett-street for the Guardians. Specifications can be obtained on application at the offices Tenders to be sent to Mr. John King, clerk, Union Offices, East-parade, Leeds, by 24th inst.

Braila.—The Municipal Authorities of Braila, Roumania, invite tenders by October 2 for the construction and working of a system of electric tramways in the city. Provisional security, 10,000f. This contract was originally fixed for July 29. Tenders are further invited by the Municipal Authorities of Braila for the lighting of the city by electricity or by electricity and gas. Provisional security 10,000f.

Chepping Wycombe (Bucks.).—The Urban Sanitary Authority for this borough are prepared to receive tenders from public companies for working the electric order obtained by them within the borough for a term of years and upon approved conditions. Tenders are to be delivered by noon on October 14 next, at the office of the town clerk, High Wycombe, where a copy of the electric order may be seen and further particulars obtained. The Authority do not bind themselves to accept any tender.

Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

Blackburn.—The Corporation of Blackburn invite tenders for the following: Contract No. 1.—High-tension concentric cables, low-tension triple concentric cables, cast-iron pipes, junction-boxes, drawing in boxes, service-boxes, etc. Specification, conditions of contract, and forms of tender may be obtained at the offices of Mr. E. M. Lacey, 10, Delahay-street, Westminster, on and after September 23, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders, sealed and endorsed "Electricity Extensions," must be delivered at the Town Hall, Blackburn, on or before October 5.

Dewsbury.—The Corporation invite tenders for wiring the Public Baths and Library. Forms of tender and copies of specification may be obtained from the borough electrical engineer, Electricity Offices, Bradford-road, Dewsbury, on payment of £1. 1s, which will be returned on receipt of a bona fide tender, together with the specification. Plans may be seen at the office of the borough electrical engineer, Bradford-road, Dewsbury, from whom any further information can be obtained. Sealed tenders must be sent to Mr. E Mawdesley, town clerk, endorsed "Electric Lighting, Public Baths and Library," not later than 12 noon on Saturday, the 21st inst.

Dundalk.—The Dundalk Town Commissioners invite tenders for erection of an electric lighting installation for the purpose of lighting the town by electricity on or about July 1, 1896, reserving to themselves the right of taking over the plant at the end of a term of years—this term to be stated in the tenders. The successful contractor to have the right of supplying private consumers, while the Commissioners will pay a fixed sum yearly for the town lighting—this sum to be stated in the tender also. The Commissioners have obtained a license from the Board of Trade for supplying electric lighting. Tenders will be received by Mr. Edward Farrar, town clerk, Town Hall, Dundalk, up to October 7.

Eccles.—The Corporation invite tenders for the supply and erection complete of the following apparatus and plant: Lancashire boilers; alternating-current dynamos and engines; cables, street boxes, etc.; transformers. Tenders may be sent in for any section or for the whole of the sections, but not for part of a section only. Plans of the district can be seen and copy of the general conditions, specification, and form of tender can be obtained on deposit of £5. 5s., which will be returned on receipt of a bona fide tender. at the town clerk's offices, Eccles, or at the offices of the consulting engineer, Mr. S. V. Clirehugh, Temple-chambers, Brazenose street, Manchester. Sealed tenders, which must be on the prescribed form, endorsed "Tender for Electric Lighting," to be delivered to Mr. Geo. Wm. Bailey, town clerk, Town Hall, Eccles, by 12 noon on 30th inst.

Belfast.—Tenders are invited for the supply and erection of two direct-coupled steam-engines and dynamos, battery of accumulators, main switchboard, and installation of about 232 incandescent lamps, complete, for the lighting of Belfast Lunatic Asylum, for the Commissioners for the Control of Lunatic Asylums. Tenders should be sent in a sealed envelope, endorsed outside "Tender for Works for Lighting Purdysburn Asylum," and addressed to the secretary, Board of Control, Custom House, Dublin, and accompanied by a separate sealed envelope, similarly addressed and endorsed, containing the detailed estimate. Forms of tender will be issued on application to the office of the Board of Control of Lunatic Asylums, Custom House, Dublin, on deposit of £1. which will be returned to all persons who have sent in bona fide tenders. Plans and specification can be seen at the office of Mr. O A. H. M'Cowen, Chapel-lane, Belfast. Tenders by 10 a.m. on 28th inst.

Harrogate.—The Corporation of Harrogate invite tenders for wiring the new Montpellier Baths for electric lighting. Specifications and full particulars may be obtained of Messrs. Baggallay and Bristowe, architects, 66, Conduit-street, London, W., on payment of £1. 1s., returnable on receipt of bona fide tender. Sealed tenders, endorsed "Tender for Wiring New Baths," are to be sent to the town clerk, Municipal Offices, Harrogate, by September 30. The Electric Lighting Committee desire tenders for the supply and erection of the following plant: (Section A) Lancashire boilers, economiser, feed pumps, and accessories; (B) steam alternators, condensers, fittings, etc., steam, exhaust, feed, and sundry pipes, valves, etc.; (C) switchboard and instruments; (F) transformers and accessories; (G) meters; (H) overhead travelling cranes. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for a portion of a section. Specifications may be obtained on application to the borough surveyor, Municipal Offices, Harrogate, on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and endorsed "Tender for Electric Lighting," must be addressed to the town clerk, Municipal Offices, Harrogate, and delivered by September 30.

RESULTS OF TENDERS.

Tunbridge Wells.—The contract for lighting by electricity St. Mark's Church, Tunbridge Wells, has been awarded to Messrs. Gilbert and Co, of 35, High-street, Kensington.

Taunton.—The tender of the British Thomson-Houston Company, Limited, at £1,058, has been accepted for supplying an alternator and engine, for the Electric Lighting Committee of the Town Council.

London, W.C.—The Guardians of St. Giles and Bloomsbury have accepted the tender of the Brush Electrical Engineering Company, 49, Queen Victoria-street, E.C., for carrying out the work required in supplying and fixing wires, cables, and fittings for the installation of the electric light at the Board-room and offices, 57, Broad-street, W.C.

Bedford.—The following tenders were received for the supply of vulcanised rubber cables, for the Urban Sanitary Authority:

Henley's Telegraph Works Company, London (accepted)	£1,797	13	3
Telegraph Manufacturing Company, Helsby	2,582	6	8
India Rubber, Gutta Percha, etc., Company, Silvertown	2,077	16	4
W. T. Glover and Co., Salford	2.131	7	1
Siemens Bros. and Co., London	2,158	12	11

Leyton.—At a special meeting of the Leyton District Council the following tenders for wiring the new public offices and technical institute were opened:

	Public offices.			Technical institute.		
Drake and Gorham	£573	14	2	£382	7	4
Paterson and Cooper	500	10	3	359	7	8
Sharp and Kent	630	15	4	402	5	2
Crompton and Co.	660	13	5	543	2	1
Strode and Co.	493	3	3	323	13	2
Joel and Co.	510	13	5	324	7	3
Wigston Electrical Engineering Company	457	14	7	303	18	6
Brush Electrical Engineering Company	472	5	11	306	15	9
Spagnoletti and Crookes	475	8	0	315	12	0

The Chairman said that Prof. Robinson was of opinion that the firms were equally good. The tenders were referred to the General Purposes Committee for consideration.

Yarmouth.—The Town Council have accepted the tender of Messrs. Bateman for coal at 14s. 6d. per ton; of the British Insu-

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lated Wire Company, at £1,031. 1s., for a new cable, including laying and jointing; and that of Messrs. Crompton for transformers—these being the lowest received.

Portsmouth.—The following tenders have been received by the Corporation for the wiring and lighting by electricity of the police stations at Buckland, Southsea, Portsmouth, and Portsea:

Newton and Co., London (accepted)	£27	10	0
S. Grossmith, Portsea	42	15	0
J. Southey, Southsea	44	19	3
A H. Wood, London	42	0	0
W. H. Sabine, Southsea	39	15	0
J. R. Penning, Southsea	39	5	0
Bowerman Bros, Southsea	41	7	6

BUSINESS NOTES.

Bristol.—Satisfactory trial runs have been made with the new electric tramcars.

Middlesbrough.—The Town Council have resolved to defer the question of introducing the electric light.

Bootle (Lancs.).—The Town Council have obtained a provisional order to carry out the system of lighting by electricity, and are formulating a scheme.

Scottish House-to-House Electricity Company, Limited.—The transfer books of this Company will be closed from September 19 to September 30, both days inclusive.

Royal Electric Company of Montreal.—The Bank of Montreal will pay, on and after the 1st prox., the coupons then due of the 4½ per cent. debenture loan for £120,000.

East Grinstead (Sussex).—The Guardians have ordered a letter from Messrs. Petit and Hards, asking to be allowed to give an estimate for the electric lighting at the workhouse, to be placed on the table.

Brighton.—A prolonged discussion took place at the last Town Council meeting with reference to the electric railway, delay having been caused in the construction of the road by a deviation in the plan.

Brussels.—The formation of the Compagnie des Tramways de Saint-Quentin is announced from Brussels. The capital is 2,000,000f. in 100f. shares. M. Victor Popp is at the head of the undertaking.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 15th inst. amounted to £1,278, as compared with £1,084 in the corresponding week of last year, being an increase of £194.

Sheffield.—The City Council have found that they must borrow £40,600 to complete their new town hall and provide it with fittings, including electric light fittings and some building work. This is in addition to £90,000 already borrowed.

Southend.—A project for lighting the Western Esplanade with incandescent gas lamps has been referred back by the Town Council until the committee has reported upon the desirability or otherwise of utilising electricity in the borough

Caddy and Co.—We have received a copy of the catalogue of the rocking, stationary, and forced-draught furnaces, fitted with tubular firebars to suit all classes of coal, made by Messrs. Caddy and Co., Limited, of Daybrook Ironworks, Notts.

Wolverhampton.—The Town Council have received a letter from the Local Government Board stating that an inspector would hold an enquiry respecting the application of the Corporation to borrow another £5,000 for extending the electric lighting works.

Llanelly.—Messrs. J. C. Howell and Co., electrical engineers, have applied to the Urban Council, asking if they were prepared to transfer to them their powers for lighting the town by electricity, and if so, upon what terms. The matter has been deferred.

Wakefield.—The tenders for the electricity supply works have been opened by the Electric Lighting Committee of the Town Council, and are now being analysed by Mr Robert Hammond, M.I.E E, of Ormond House, Great Trinity-lane, E.C. They number 49.

Aberdeen.—We are in receipt of a letter from the British Insulated Wire Company stating that the whole of the extensions at Aberdeen this year requiring cables have been carried out by them, and that our note in the Aberdeen number *re* extension of mains hence needs correction.

Earlston (Berwick).—Negotiations are still going on with a view to the introduction of the electric light in Earlston. The proposal has been very warmly received by the inhabitants generally, and there is a marked preference for the electric light over the proposal to purchase the gasworks.

City and South London Railway.—The returns for the week ended September 15 were £808, compared with £826 for the corresponding period of 1894, being a decrease of £18. The total receipts for the half-year 1895 are £9,316, compared with £9,402 for the corresponding period of 1894, being a decrease of £86.

Direct Spanish Telegraph Company.—The Board of the Direct Spanish Telegraph Company have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent., free of income tax, on the ordinary shares, both for the half-year ending June 30.

Appointment Vacant.—An assistant demonstrator in the department of electrical engineering at the City and Guilds Technical College, Finsbury, is required. One having experience of alternate-current work preferred. Salary to commence at £80 per annum. Apply to the Principal, City and Guilds Technical College, Finsbury.

Whitehaven.—The Town Council have received several informal applications for supplies of the electric current in Duke-street and elsewhere, and the surveyor has submitted alternative schemes for laying a cable in Duke-street, and has been instructed to prepare a statement showing the available electric lighting capital and the estimated outlay against it.

Worksop.—Complaints were made at the last Urban Council meeting of the inefficiency of the gas supply, but several members were in favour of letting the gas question alone on the ground that in all probability the town would eventually adopt the electric system of lighting, and that a company was about to be formed for the purpose of introducing the electric light to Worksop.

Swansea.—The scheme for lighting the main streets by electricity, and at the same time using the plant for the purpose of destroying the town refuse, is now complete. The Corporation Committee have finally considered the report, which will be presented to the Corporation. The work, which is to be carried out under the superintendence of Mr. Manville, will cost about £50,000.

Ashton-under-Lyne.—The question of providing an electric installation for the borough is under consideration. Alderman Andrew said, at the last Town Council meeting, that the users of the light ought to bear the burden, and the general ratepayers ought not to be saddled with any part of the cost except in regard to public purposes like street-lighting and the illumination of the Town Hall.

Kettering.—The Urban Council have appointed a committee of eight members to take into consideration the supply of electricity for lighting and other purposes, and to call expert evidence if necessary, the latter not to exceed a cost of £30. Speaking in support of the motion, Mr. Gorman said he had been given to understand that if the Council did not take the question up a company would be formed in the town.

Queenstown.—The Town Commissioners have received several applications to tender for lighting the town by electricity. The Chairman said at the last meeting that it was well that the public should know that the Commissioners were strong in their determination to have the town lighted by electricity, but with a clause inserted in the agreement that after a certain number of years the plant would become the property of the town.

Aberdeen.—The Education Committee of the Governors of Gordon's College have received a letter from Mr. E. T. Ruthven Murray, formerly electrical engineer to the Corporation of Aberdeen, with reference to the electric lighting of the college. Mr. Murray explained that, after full consideration, he thought the amount mentioned in a previous letter quite sufficient to cover all outlays in connection with the introduction of the lighting. It has been agreed to give Mr. Murray an honorarium of 20 guineas for his services as engineer on the occasion of the installation.

South Staffordshire Tramways.—The last extension granted to the South Staffordshire Tramway Company for the use of steam on their lines between Darlaston and Handsworth has expired. It has been rumoured that the company have secured a further extension of several months, on the understanding that this will be the final one. It is reported that steps are being taken to convene a conference of representatives of the different corporations concerned, and this will be held at an early date, when it is expected that some arrangement will be arrived at on the subject.

Yarmouth.—The surveyor of the Town Council has reported to the Electric Lighting Committee that since the last meeting applications had been received from six customers for 238 lamps, the total number of customers now being 105 for 5,360 lamps. The income for the month of August had been £162. 7s. 8d. The expenditure amounted to £108. 18s. 9d. There had thus been earned beyond cost of production the sum of £53. 8s. 11d. Fuse-boxes and meters were required to the amount of £62. 10s. They would be paid for out of loans. The committee directed the borough surveyor to obtain the goods asked for.

Bath.—The Bath City Council have, upon the recommendation of the Lighting Committee, decided to make an application to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 to 1890, giving the authority power to take the electric lighting of the city under their own control. At present it is in the hands of a company, who some time since applied for the Council's consent to their application for the provisional order, but this was refused. Alderman Clark, who supported the recommendation of the committee, said he considered it desirable that the city should have power to supply electric energy in the same way as it supplied water.

Battersea.—The special committee appointed by the Battersea Vestry to consider the question of electrically lighting the parish have presented a report on the subject, in the course of which they state that after due enquiry and consultation with Dr. J. Hopkinson, F.R.S, they are not prepared to recommend the adoption of a scheme for utilising the dust destructor in connection with the electric light. After careful consideration they have resolved to invite competitive schemes for lighting the parish, and to offer premiums for the three best. With a view to the Vestry applying to the Board of Trade for a provisional order, the necessary notices

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have been given for a statutory meeting of the Vestry to sanction such application.

Hove.—The Hove Electric Lighting Company, Limited, are prepared to receive applications for the unallotted portion of the Company's shares and 4½ per cent. debentures. The £5 shares are offered at £5. 5s. each, and the debentures at the price of £103 per £100 debenture. In addition to providing the debenture interest and all other charges, the Company paid a dividend for 1894 at the rate of 3 per cent. per annum on shares. The receipts from customers for current for the first six months of the present year are more than double the receipts for the corresponding period of the year 1894, and the directors confidently anticipate paying a satisfactory dividend for the current year.

Dewsbury.—The Town Council have resolved that the town clerk write to Mr. W. H Preece to ask that he will use all possible expedition in having all the contracts in connection with the electric lighting department brought to a speedy and final settlement. A letter has been received from the Westinghouse Electric Company, with respect to their claim for royalty under the Hopkinson patent, for the use of the three-wire system, and the town clerk was directed to make further enquiries in the matter, and endeavour to arrange for an interview on the subject between the company and Mr. Preece The Council have resolved that it cannot agree to quote a reduced price for the supply of electricity for the lighting of the post office premises.

Liverpool.—The Mersey Docks and Harbour Board give notice that during September a cable will be laid from the Formby Lightship to the Crosby Lighthouse, by means of which electrical communication will be established between the said lightship and lighthouse. In the last session of Parliament a Bill was introduced with reference to the Corporation and the Electric Supply Company's undertaking, but the session came to an end before the measure could be passed. The company's agreement with the Council would in the ordinary course of events come to an end on December 31 this year, but at a meeting of the Special Lighting Committee a communication from the company was read, and it was resolved to extend the term of the agreement for 12 months.

Huddersfield.—The town clerk (Mr. F. C. Lloyd), at the last meeting of the Town Council, defined the law with regard to rights of owners of property and land which was crossed, although not touched, by telephone and telegraph wires. The Town Clerk explained that these owners had exactly the same rights as owners whose property was touched by telephone wire appliances, and could exact sums for wayleave. There was here a question for the Corporation. Overhead wires crossing the streets, he said, were a cause of risk and annoyance to the inhabitants, and they certainly disfigured the town greatly. The Council would require to obtain further parliamentary powers very shortly, and this was one of the points that would be considered by the Parliamentary Committee.

Halifax.—Recently the Halifax Chamber of Commerce made representations to the National Telephone Company respecting complaints in the district as to the inefficiency of the service, the chief grievance being the delay experienced in obtaining trunk communication. It was suggested, among other things that more trunk lines should be laid. The general manager of the company (Mr. W. E. L. Gaine), Alderman Frankland, a director, and the local managers have met a committee of the Chamber at the Town Hall, and the various complaints were fully gone into. Mr. Gaine promised that where possible the grievances should be remedied. With regard to the trunk service, he said the postal authorities would have to be consulted before additional lines could be laid. The company, he added, was wishful to improve the service in the district, and to comply with the wishes of the Chamber.

General Electric Company, Limited.—This Company. who are the owners of Patent No. 3,664, dated February 28, 1891, and entitled "Improvements in Electrical Switches," have granted licenses for the manufacture and sale of the well-known switches called "Tumbler" or "Link" switches (with either a link movement or a heel piece) to the following firms: the Edison and Swan United Electric Light Company; Messrs. Evered and Co, Limited, of London and Birmingham; Messrs. McGeoch and Co., of London and Glasgow; Messrs. Verity and Sons, of London and Birmingham: Messrs. Bayley Bros., of Walsall; and Messrs Tucker and Co., of Birmingham. We have received the new editions of the electric bell and telephone catalogues of the General Electric Company. Both have been considerably enlarged, and no trouble or expense have evidently been spared in getting up good illustrations and descriptions of the various articles listed. In addition to the prices, illustrations, and descriptive letterpress, each list contains a carefully written practical treatise upon its particular branch and a copious index.

Folkestone.—There has been a special meeting of the Corporation to "receive the report of the Special Electric Lighting Committee appointed on September 26, 1894, on the scheme for lighting the borough by electricity, and to consider the same; and to make orders and pass resolutions with reference thereto." Councillor Baker moved that the report be adopted. It was a scheme formulated by Mr. Francis H. Medhurst to cost about £13,000. Councillor Baker went through all the points in the report, and contended that, for all practical purposes, it was as effective as Mr. Parker's scheme to cost £35,000. Councillor Payer seconded. Councillor Thompson then produced a type-written document, which he proceeded to read, interlarding it with long extracts from electrical journals. He eventually suggested, as there was no chance of their coming to a conclusion, the two schemes should be submitted to an expert. This would have involved an outlay of probably 100 guineas. It was therefore moved by Alderman Salter, and seconded by Councillor Harrison, that the matter be adjourned *sine die*, and this was carried.

Morecambe.—The Urban District Council have received the report and valuation of Mr. Parkinson, the electrical engineer appointed by the Council to value the works of the Morecambe Electric Light and Power Company, Limited, and his report on the best system of lighting the town by electricity. At the last Council meeting Mr. Parkinson explained his valuation and system of lighting Morecambe by electricity. It was resolved that an offer be made to the company for the purchase of the plant, parliamentary powers, and undertaking, excluding the gas-engines, gas apparatus, dynamos, belting, and transformers, enumerated by Mr. Parkinson in his report, for the sum of £4.125, such offer being conditional upon the Council obtaining all necessary powers and authorities and also the consent of a meeting of owners and ratepayers of the district.

Windsor.—Councillor Caley enquired, at the last Town Council meeting, if anything further had been heard respecting the electric light. Mr. Atkins (the town clerk's assistant): Nothing. Councillor Caley: Then I suggest that steps be taken immediately to see if it cannot be carried on. I suggest that the Electric Lighting Committee be called together. Alderman Dewe said the last time he saw Mr Lovegrove he said he had received no communication from Mr. Medhurst, and until they heard from him it was of no use to call the committee together. Councillor Caley said he did not know why they were waiting for Mr. Medhurst. The suggestion for him to ascertain the water power was purely his own. He thought they might get on with other matters and leave the consideration of his report until they got it. Alderman Dewe explained that the committee had an interview with Mr. Medhurst and Mr. Liardet, who told them they could save much money by adopting their proposal to use the water power. The committee were expecting a report from these gentlemen, and he could not see how the matter could be settled until that report came.

Manchester.—The Corporation have begun operations which will enable them to provide the electric light to private premises in Oxford-road as far as Whitworth Park. At present the supply of electric light goes no further than the canal bridge near Whitworth-street. It is not immediately contemplated to provide for public lighting, nor is it likely that the extension to Whitworth Park will be completed this winter. The work, however, has already been begun, and operations of a similar nature are in hand in Stretford road and in Downing-street, where it is proposed to carry the light as far as Ardwick-green. A correspondent writes to a local paper: "Permit me to protest against the bad lighting of our Comedy Theatre. From the time of opening the doors until the performance commences the light is a wretched one. When a complaint is made to the officials they reply that electric light is expensive; but seeing that the theatre is supplied with gas also, this explanation is scarcely satisfactory. I think it is only necessary to call the attention of the theatre authorities to this evil to have it remedied, for the sake of the large number of people who prefer to go early to the theatre, and who, like myself, have so far had great reason to complain."

Bury St Edmunds.—The incandescent gas light has been much pushed by a local firm and largely adopted in the shops of the town. It is interesting, however, to note that one of the first results has been the putting in of two small electric light installations, of which one probably, and the other avowedly, has been prompted by a desire to go one point better. The first is the property of a small syndicate and though not yet out of the hands of the engineers (Messrs Crampton and Co., of Cambridge), has been running some little time. It consists of a Crossley gas engine, dynamo, and accumulators, and is intended to supply several shops with light for both business and domestic purposes at a charge of 7d a unit. At present rather more than 150 incandescent lamps have been put in. The price of gas is 3s. 6d. per thousand. The second installation, which is in process of completion, is designed on different lines. It is to consist of about 70 incandescent lamps fitted in a single shop (Messrs. Plumpton and Sons), and will be run only during business hours, so that the number of lamps on will be practically constant. Gas is to be retained for domestic use. The dynamo is driven by a Crossley electric light engine, and accumulators are to be dispensed with. The work has been done by Messrs Laurence and Scott, of Norwich. Other installations are talked of. Up to the present time the Town Council has been strongly opposed to the introduction of the electric light, but now that the private consumer is taking the matter into his own hands there will almost certainly be a change of policy, and probably a scheme of public lighting.

Copper Deliveries during the first fortnight of this month exceeded the supplies by nearly 1,500 tons, so that the statistical position, the *Financial News* thinks, is still very promising for a maintenance of prices American arrivals were again agreeably small, and the imports from other quarters were but moderate. The visible stock is now 53,969 tons, against 55,432 tons at the beginning of the month.—In a copper trade circular from New York, dated September 3, it is said the general trade prospects in the United States continue of a very hopeful character. The coming fall is likely to see an unusual expansion of business transactions. As respects the copper position it is remarked that "there may not be a famine for it, but with the unprecedented demand and every prospect of an increasing consumption for years to come, the most conservative must be convinced that copper is making new history for itself. Electricity is putting in its claims in a most urgent manner, and the popular demand for electric transit will lead to the introduction of the electric railway in many new localities. These electric roads are spreading wonderfully. In the

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past 20 years it is estimated that the number of miles of railway track electrically equipped in the country has increased from 7,466 to 10,363 miles. These electric railways will transform many outlying districts into centres of activity, and the end of their development is by no means in sight. Long-distance transmission of electrical power has also now become an assured success, and its introduction in various directions in the different countries of the world must have a most important bearing on copper consumption. The outlook for copper is indeed nothing short of brilliant."

Ayr.—The town of Ayr, a corrrespondent writes, is now within measurable distance of the date at which the electric light will be illuminating its principal streets, public works, shops, and many of its houses. It was at one time expected that the current would be turned on for the race meeting, but this expectation is not to be realised, and the period has had to be extended to a time limited to the end of October, when if nothing untoward occurs, it will have largely superseded gas as an illuminant. Under Mr. Hammond and his assistant, Mr. E. G. Pink, who has been appointed burgh electrical engineer, the work has been proceeding during the last 12 months. The generating works occupy a central station on the south bank of the River Ayr, about 100 yards below the railway bridge, which is within the tidal influence Part of the buildings abut on the river, from which they are protected by a concrete wall, and access is had by Mill-street. The buildings are of the usual character, including power-house, boiler-house, and offices. The principal feature is the power-house for containing the generating machinery, which is a spacious building and well lighted. The power is supplied by two boilers, 28ft. by 7ft., fitted with mechanical stokers, and each capable of supplying 200 h.p. The system upon which the installation is based is the high-tension alternating. To generate the current, there are four sets of engines in the power-house. The two principal engines each drive a 100-kilowatt alternator by Siemens and Co., Woolwich, which gives 50 amperes at 2,000 volts. The principal machines are capable of supplying light to the amount of 6,600 8-c.p. lamps, and a 50-h.p. machine 850 8-c.p. lamps. The total amount of light, measured in candle-power, is thus nearly 70,000 candles. The plant may yet be used to work a tramway between Burns's Monument and Prestwick through Ayr, a distance of about six miles.

Cardiff.—Mr. S. F. Walker writes to the *Western Mail:* "I cannot help once more warning the Cardiff County Borough Council that they stand to have even more trouble with their arc lamps during the coming winter than they had during last winter. All the conditions are the same, except that, there being more incandescent lights attached to the supply, and in particular some large buildings, the rectifiers will be even more likely to lose that current at uncertain periods than when they were first started; and, in addition, the arc lamps themselves are likely to give more trouble individually from the wear of the last nine months. Why not take the bold course that will end all their troubles and move the generating station to the centre of the town? As an instance of the different results that may be obtained from the policy I have so persistently advocated, I would instance, among others, the city of Lancaster. There an old pupil of mine is borough electrical engineer. He has laid down a station whose possible output is nearly as large as that of the Cardiff generating station; his scheduled area is considerably larger than that of Cardiff (the area over which his distribution extends); he has spent less than half the amount that has been spent in Cardiff; and he has made a profit on his first year's working, while we stand to lose £6,000. He has done this simply and solely because he has placed his generating station within his scheduled area, and has used low-tension continuous currents in place of high-tension alternating currents. We are not accustomed to look upon cathedral cities as patterns of enterprise or of good management, but in this case certainly the Chicago of the old country might take a good lesson from Lancaster as well as from other towns Few towns have so many natural advantages for the successful and economical adoption of the electric light. Hardly any town has done worse." To this Mr. Frank Baines, of London replies: "I have read with much interest the effusions of Mr. S F. Walker, as published in your columns during the past two or three years, and more particularly the last letter from his pen. It seems to me that there is only one remedy for the defective or alleged inefficient lighting in Cardiff, and that there is only one man in the world who is capable of effectually enforcing that remedy. That man is Sydney F. Walker, and the remedy is for the Corporation to make Mr. Walker a present of the generating station and plant. If this were done, nothing further would be heard from him on the choice of the alternating system in conjunction with rectifiers." At a meeting of the Lighting and Electrical Committee of the Cardiff Corporation a deputation, representing the High-street Arcade Company and the tenants of the shops therein, mentioned the desirability of lighting the arcade by electricity. It was pointed out that the substitution of the electric light for the ordinary gaslight would have a beneficial effect upon the atmospheric conditions of the arcade, and would be a great inducement to tradesmen to become consumers. a number having already signified their intention of using the light on condition that the arcade be so lighted. The committee have instructed the borough engineer to report on the cost by the next meeting. It was stated that the arcade was within the area, and that provision had been made for laying these mains in the application to the Local Government Board.

Exeter.—A report has been made by the city engineer to the sub-committee charged with investigating the details of the question as to the purchase by the City Council of the electric light undertaking. He stated that he found the steam machinery was in good order, and, with the exception of a small high-speed engine, could be economically worked. He considered that the value of the undertaking was £7,556, but recommended that an expert should be called in. Dr. Fleming was consulted, and asked to report whether the Corporation would be well advised to purchase the undertaking for £10,000, and if that sum was the proper value; and if not, whether it would be advisable for the Corporation to acquire the provisional order and the undertaking. He did not think the works as they stood were calculated to do all that would be required of a corporation which undertook electric lighting The plant, with some small possible extensions which he suggested, would not be sufficient to meet more than an additional demand for another 2,000 8 c p. lamps to be added to the circuit, and the limit of the supply capacity would be an additional 8,500 8-c.p. lamps. The general opinion he had formed of the generating station and its equipment was that the station was not laid out in the beginning with sufficient forethought and provision as to future extensions and requirements; secondly, that the general design showed a want of engineering skill, and not sufficient care in the utilisation of the available space; thirdly, that the plant selected, speaking electrically, was not up to date in its efficiency and design; fourthly, that some portion of the plant would have to be replaced by improved and more efficient machines if the undertaking was to be put on a sound basis Having regard to these circumstances, he did not think the undertaking was worth £10 000. With regard to the second question referred to him, Dr. Fleming said if the Corporation either possessed a provisional order or could obtain one he would not advise the purchase of the present electric lighting company's plant on any terms, because he did not think it was sufficiently modern or efficient to render it a desirable acquisition, nor was it capable of the extension which a corporation electric lighting station should be. At the same time he was somewhat reluctant to suggest that the Corporation should abandon the idea of undertaking the supply of electricity, because that might afterwards prove to be a mistake He had carefully considered if the works could be taken over on any terms, and whether they could be made self supporting. If certain suggestions he made were carried out, it was possible to make the gross revenue exceed the gross outlay by £200 or £250. He had made a valuation of the plants and works on the basis that the undertaking could not be of any value to the Corporation at all, unless it could be shown not to be a loss-making concern. His estimate was £7,110, to which must be added the cost of obtaining the provisional order, £426, making a total of £7,536. There is only £20 difference between the estimate of the city surveyor, Mr. D. Cameron, and that of Dr. Fleming. After considering the reports the sub-committee came to the conclusion that it was not advisable to give £10 000 for the works. Their recommendation has been considered by the Council in committee and adopted. After some discussion it was decided to recommend the Corporation to offer the company £7,500 for their undertaking. The Corporation have adopted the report of the sub-committee by 21 votes to 10, and decided that the offer should be made subject to the approval of the Board of Trade, and to the sanction of the Local Government Board to the borrowing of the money.

Tunbridge Wells.—In the course of an article on "Electric Lighting at Tunbridge Wells," in a local paper, Sir David Salomons, Bart., says: Now that the advantages which can be obtained by the adoption of the electric light are within the reach of every inhabitant of this town, it may be desirable to mention a few points in connection with this modern illuminant for the information of those who have not the time or opportunity to follow recent developments of the applications of science. A great deal has been said on the supposed extra cost of the electric light as compared with gas. The charge per unit in this town for electric energy is 6d., and if householders are careful to make use of the easy method of turning off the light on leaving a room and at other times when the light is not required, since it can be switched on again with equal ease when desired, it will be found that the cost is decidedly less than that of gas at its present price in this town, and also less than the cost of lamps and candles light for light The householder should take into consideration the fact that when he adopts the electric light, he not only dispenses with his gas bill, but also with the cost of oil and candles, and these latter are not an inconsiderable item. He must also bear in mind that, when the new illuminant is installed, he obtains a better light in his room than he did in the olden days, and that he also preserves his decorations. It is only natural that a timid body like gas shareholders should feel nervous at seeing the introduction of the electric light. This, in itself, might be taken as a sign that they believe their own wares are inferior to the new ones, but the advance of the electric light will not be stopped by any action on their part any more than was the advent of railways retarded by the coachdrivers of those days. But at least I can hold out a little comfort to the gas shareholder when I say that the gas-burners which will be replaced by the electric lamps will not seriously affect the company's returns. In private houses, the number of electric lamps which are likely to be inserted will, for the sake of convenience, be greatly in excess of the present number of gas-burners, for the reason that the sitting-rooms will use the new light where in most cases gas does not now exist. In shops no doubt the electric light will almost entirely supplant gas, owing to the greater effect obtained in the display of goods. On the other hand, gas stoves of proper construction are likely to increase in number in the town, for the very reason that the electric light makes its appearance. In the City of London, where the gas interest is vastly more powerful than at Tunbridge Wells, the attempts to damage the new

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illuminant were powerless. Even the fuss which has been made over the incandescent lamp burner was of no avail. The light from such burners is injurious to the eyes, which I can personally answer for, having used it myself and been obliged to give it up. Besides this, although it is economical when calculated by candle-power, economical burners are not yet produced, and therefore the advantage on this score is a pure delusion. I have had myself experience of gas in London succeeded by electric energy sold at 8d. per unit and later at 6d. per unit. I can testify to the fact that the electric light bill when the unit was 6d. was less than the gas bill. In the City of London, although the price per unit is 8d. for the reason that there are only 5½ working days in the week instead of seven, as in other places, yet I have many testimonials showing that the electric light bill was less than that of gas in those offices and warehouses where due regard was given to turning the lamps on and off as they were required. There is, however, one point which is of great interest to householders, and appeals more forcibly to the trade and landowners of this town than perhaps any other. It is that of health. At the present time the death-rate of Tunbridge Wells is under 14 per 1,000 and I believe this can be greatly reduced by the general use of the electric light. In the case of the light given by electric incandescent lamps, the tendency to injure health and shorten life is totally absent. Supposing the electric light were to cost double the price of gas, which is not the case, there would still be a large saving in doctors' and chemists' bills, a better temper prevailing in the household, and no dread of long winter evenings. Work could be continued after dark without distress, book-bindings will remain as good fifty years after leaving the binder's hands as on the day they were bound, furniture and decorations will not be injured, and the householder will find himself richer every year due to these causes, quite apart from the enjoyment of better health, which will enable him to enter on his business duties with that vigour and clear mind which is absent from the inmate suffering from poisonous and gas-vitiated air.

PROVISIONAL PATENTS, 1895.

SEPTEMBER 9.

16826. **Improvements in the electrolysis of saline solutions.** Emile Andreoli, 18, Somerleyton-road, Brixton, London.

SEPTEMBER 10.

16866. **Improvements in arc lamps.** Edward Jesse Piper, 34, Victoria-street, Westminster.

16897. **Improvements in holders and supports for electrical candles.** Hugo Hirst and William Everett Gibson, 73, St. Stephen's-road, Upton Park, London.

16898. **An improved wall socket and plug for electric lighting and kindred purposes.** Gustav Binswanger, 73, St. Stephen's-road, Upton Park, London.

16910. **Improvements in and relating to power-transmitting mechanism for the power shafts of electric and other high-speed motors.** Daniel Stephen Regan, 77, Chancery-lane, London. (Complete specification.)

16918. **An improved junction coupling for electric lighting installation.** Hahnemann Adolphus Cutmore, 172, Queen Victoria-street, London.

16924. **Improvements in electric fire alarms.** Charles Darwin Tisdale and John Duncklee Gould, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16925. **Improvements in electric fire alarms.** Charles Darwin Tisdale and John Duncklee Gould, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

16939. **Improvements in electric locomotives.** James Devonshire, 70, Chancery-lane, London. (Edwin W. Rice, jun., United States.) (Complete specification.)

16940. **Improved electrical tool.** Fredric Joseph Warden-Stevens, 70, Chancery-lane, London.

16950. **Electrolyte baths, appliances, and system.** James Henry George, 44, Broad-street, New York, U.S.A.

16952. **Improvements in incandescence electric lamps.** Walter Rowbotham and Hymen Levetus, 45, Southampton-buildings, Chancery-lane, London.

SEPTEMBER 11.

437A. **Improvements in and connected with arc lamps.** John Brunswick Barton, 18, Southampton-buildings, Chancery-lane, London. William Jandus, United States). (Date claimed under Patents Rule 19, January 7, 1895.)

17004. **Improvements in and in the method of constructing incandescent electric lamps.** Percy Richard Julius Willis, 55, Chancery-lane, London. (Robert Greer, United States.)

SEPTEMBER 12.

17058. **Improvements in periodically ringing bells and sounding whistles, syrens, or the like, and registering the same, and in electrical apparatus therefor.** Frederick Herbert Berry, 168, Fleet-street, London.

17063. **Improvements in electric smelting.** Thomas Leopold Willson, 55, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, February 20 1895, being date of application in United States.)

SEPTEMBER 13.

17123. **Improvements in linked suspensions for electroliers, electric light pendants, and the like.** Hugo Hirst, 73, St. Stephen's-road, Upton Park, London.

SEPTEMBER 14.

17205. **Improvements in machinery or arrangements for lifting, lowering, carrying, or transporting leads, actuated by electricity.** John Audley Frederick Aspinall, 5, Market-street, Manchester. (Complete specification.)

17210 **Improvements in the manufacture of electrical resistances.** Augustus John Marquand, Emmanuel Hancock, and David Lowdon, 24, Southampton-buildings, Chancery lane, London.

SPECIFICATIONS PUBLISHED.

1891.

19071.* **Incandescent lamps.** Langhans. (Amended specification.)

1893.

6780 * **Secondary batteries.** Doubleday. (Sussmann.) (Amended specification.

1894.

12045. **Secondary batteries.** Schanschieff.

16418. **Telephonic apparatus.** Cerpaux and another.

16999. **Electric switch.** Cowper-Coles and Alliott.

17761. **Arc lamps.** Brockie.

17922. **Arc lamps.** Immler.

19877. **Electrically-heated grills.** Schlinder.

20017. **Arc lamps.** New and Mayne.

1895.

13348. **Distributing power by electricity.** Royce and Claremont.

13380. **Electric lighting.** Moskowitz and others.

13411. **Distributing power by electricity.** Royce and Claremont.

13416. **Electric lamps.** Walters.

13635. **Electric gas lighters.** Grier and others.

13978. **Stopping electrically-propelled cars.** Bonta.

14014. **Electric switch.** Jones. (Stuebner and others.)

14049. **Arc lamps.** Higham

14114. **Electrical apparatus.** Hessberger.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5½-5⅝
Brush Company, Ordinary	3	1⅛-1¼
—— Nom. Cum , 6 per cent. Pref.	2	1⅞-2
—— 4½ per cent. Debenture Stock	100	111-114
Charing Cross and Strand	5	5½-5⅝
Chatham and Rochester	—	—
Chelsea Electricity Company	5	7-7½
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	14-15
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	133-137
City and South London Railway, Consolidated Ordinary	100	38-40
—— 4 per cent. Debenture Stock	100	134-126
—— 5 per cent. Pref. Shares	10	14½-15½
County of London and Brush Provincial Co., Ordinary	10	8¼-9¼
—— 6 per cent. Cum. Pref.	4	6¾-7¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1-2
Edis n and Swan United Ordinary	3	2-2½
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅞-1
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	2⅛-2¼
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	1-1⅛
Fowler-Waring Cables	5	1-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	12½-12⅝
—— 7 per cent. Preference	10	15-16
—— 4½ per cent. Debentures	100	104-107
House-to-House Company, Ordinary	5	3¾-4
—— 7 per cent. Preference	5	7¼-7½
India Rubber and Gutta Percha Works	10	19-21
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	7-7½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅞-8⅛
Liverpool Overhead Railway	10	12⅞-13⅛
—— 5 per cent. Pref.	10	15-15½
—— 4 per cent. Mortgage Debentures of £100	100	111-113
Metropolitan Electric Supply	10	12½-12¾
—— 4½ per cent. First Mortgage Debenture Stock	100	117-119
National Telephone, Ordinary	5	6½-6⅝
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Non. Cum. Third Pref.	5	6½-6⅝
—— 5½ per cent. Deb. Stock	100	106-108
Notting Hill Company	10	8¼-9½
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	5	7½-7⅞
—— £4½ shares	4½	6-6½
Royal Electrical Company of Montreal, 4½ per cent First Mortgage Debentures	—	105-107
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8½-8¾
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4½-4¾
Westminster Electric Supply, Ordinary	5	8¾-9¼
Yorkshire House-to-House	5	5½-5⅝

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NOTES.

The New Taxes upon Gas and Electric Light in Italy, particulars of which were given in our issue of July 12 (page 29), enter into force on November 1, 1895.

Obituary.—Mr. Paul Prince, superintendent of the Midland Railway Signalling Department, whose death occurred on Tuesday, was the originator of some important electrical patents.

Telephony in Mexico.—A Mexican newspaper urges that the further development of the telephone industry should be stopped, "as it will ruin railways and hotels by rendering travelling unnecessary"!

Telegraphs in Nyassaland.—The *British Central Africa Gazette* states that, in addition to his administrative work, Major Forbes is charged with the completion of the Blantyre-Tanganyika telegraph line.

The Bordeaux Exhibition.—It is rather curious that the explosion of a gas-engine at the exhibition at Bordeaux should cause a serious fire to break out and totally destroy the electricity pavilion.

A Curious Accident is reported from the Grand Rapids, Michigan. A little girl was playing at the corner of a street, when a lamp trimmer threw a carbon from the top of the electric light tower. The missile fell 150ft., striking the child's right eye, and unfortunately destroying the sight.

The Lighting of the Holstein Canal.—Herr Bänsch, the engineer of the Kaiser Wilhelm Canal, has gone to Rendsburg with a view to investigating the working of the electric lighting of the waterway. A squadron of first-class ironclads is, it is stated, about to make a trial trip through the canal.

French Telephonic Courtesy.—A Reuter telegram from Paris says that during the Marquis of Salisbury's stay at Dieppe the French Government has shown the greatest courtesy to him. M. Hanotaux, the Minister for Foreign Affairs, offered to have a telephone laid between the Châlet Cecil and the British Embassy in Paris.

Telegraphs on the Amazon.—A party of English engineers have begun surveys of the Amazon for the new cable between Pará and Manáos. They are accompanied by a Mr. Reidy, who will arrange for the necessary cable stations along the river. It is expected that the work of laying the cable will be begun before the end of the year.

Electric Staff Instruments.—Major Marindin has recommended the directors of the Dublin, Wicklow, and Wexford Railway Company to make a trial of an invention which, on lines worked by the electric train-tablet, locks the starting signal at a station at danger until a tablet has been withdrawn at this station. He has no doubt that this invention could easily be made applicable to electric staff instruments.

A Narrow-Gauge Electric Locomotive.—We regret that a few errors crept into the article on this subject in our last issue. The locomotive when loaded and climbing the heaviest grade takes 45 amperes, not 450. The rail bonds have split cylinders at each end, which are expanded into contact with the web of the rail. Messrs. Holroyd Smith and Ravenshaw are to be congratulated on the way they carried out the above work at Chatham.

Lighting in Italy.—*L'Elettricità* of September 22 says that the experiments with the oxy-hydrogen light as an illuminant at Spoleto, in Perugia, are being watched with considerable interest and satisfaction. The light, which is described as being "perfectly white like sunlight and not starlike as in the case of the electric arc," is obtained by the decomposition of water by electricity, the perfection of the process being attributed to Prof. Garuti Pompeo.

The Rustchuk-Sofia Telephone was opened at the beginning of the present month. It is proposed to extend it to Bucharest. The telephone line between Sofia and Belgrade is already in course of erection, in connection with the projected Belgrade-Budapest wire. Should the Bulgarian efforts to establish the planned Sofia-Constantinople line be successful, there would then be uninterrupted telephonic communication between Berlin and the Turkish capital.

A Telephone War is said to be raging in Kansas between the Missouri and Kansas Telephone Company and the Harrison International Telephone Company. The "battlefields" are principally Topeka, Leavenworth, Wichita, and Salina. "The war has even run over into St. Joseph and Carthage, in Missouri. In Wichita the Missouri and Kansas Company has just offered telephone service at 30dol. for residence and 36dol. for business houses for a year. In Salina, telephone service is practically given away."

The Cardiff Exhibition.—The Cardiff Fine Art, Industrial, and Maritime Exhibition will be opened in May, 1896, under the patronage of her Majesty the Queen and the presidency of the Right Honourable Lord Windsor, lord-lieutenant of the county of Glamorgan, and continue open during six months. Among the sections will be one devoted to "machinery, electricity, and local and general industries," while another will embrace "scientific instruments, specimens, and inventions." The hon. secretary of the exhibition is Mr. Walter Cook, of St. Mary-street, Cardiff.

Chesterfield and Midland Counties Institution of Engineers.—A special general meeting of the members of the institution (Mr. Emerson Bainbridge, M.P., president) will be held in the Stephenson Memorial Hall, Chesterfield, on Saturday, October 12 proximo, at 3 p.m., when the president will deliver an address, and the following papers, amongst others, will be open for discussion: "Continuous-Current Dynamos and Motors: Choice of Plant, Fixing, and Driving, usual Faults and their Remedies," by Mr. Lancelot W. de Grave (adjourned from Nottingham meeting, March 16, 1895); "Photometric Value of and Notes upon Various Illuminants used in Mines," by Mr. A. H. Stokes (adjourned from Warwick meeting, July 13, 1895).

The Cost of Incandescent Lamps in Germany. The *Zeitschrift für Beleuchtungswesen* gives the following as the net cost of manufacture of electric incandescent lamps in Germany: globe 0·48d., platinum 0·96d., filament 0·24d., cement and attachment 0·24d., glass neck and vacuum tube 0·18d., total 2·1d.; working the filament 0·24d., conductors 0·12d., fixing filament on conductors 0·06d., preparing for vacuum 0·3d., vacuum 0·3d., photometry 0·12d., fixing neck and soldering 0·24d., cleaning and testing 0·12d., total 1·5d.; general expenses 0·24d., current 0·24d., gas 0·06d.—total 0·54d.; total cost per lamp, 4·14d., to which add 10 per cent. for breakages, making 4·554d. per lamp. The cost of packing and that of heating and lighting the works, together with the interest on capital, bring this up to 5·346d. per lamp.

Electricity in the Russian Army.—The Russian army authorities, *L'Etincelle Electrique* of September 20 says, have decided to establish a scientific branch of the service under the direction of a lieutenant-general, two

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major-generals, and five officers of lower grades, whose business it will be to work out the applicability of electrical discoveries to war purposes. In addition, an electrotechnical school has been instituted under the direction of a major-general for the purpose of giving a 19 months' course of instruction to 35 lieutenants and sub-lieutenants of Engineers. This school will also serve to train an electrical company recruited from mechanics and from selected non-commissioned officers of Engineers, who, after passing through the school, will go back to their regiments and there be available as instructors.

Sir David Salomons and Tunbridge Wells.—An effort is being made to induce Sir David Salomons to again consent to be mayor of the borough of Tunbridge Wells. The Reception Committee of the Town Council, who organised the arrangements last year, have decided to present a memorial to Sir David, acknowledging the many good services that he has already rendered the borough, and expressing the hope that his worship may see his way to continue in office for another year. The honorary secretary has communicated with various institutions, including the Tradesmen's Association, who have unanimously decided to support the Reception Committee, and we believe that the memorial is being extensively signed by all classes. By the bye, when the mayoress formally opens the new central electric lighting station next month, all the local bodies will join in an imposing procession round the borough.

Electric Traction in London.—Every week seems to produce a new London railway scheme, the latest report being that a syndicate proposes to take over the London, Chatham, and Dover Company's Metropolitan Extension line from Ludgate-hill to Victoria in order to experiment with electric traction. The report, which seems to emanate from the City, states that the Chatham Company's Ludgate-hill-Victoria line offers a ready-made track very suitable in every way for electric power, and that it could be completely isolated from the main line, while the cost of electric equipment would be small compared with the enormous increase of traffic and of net receipts obtainable. A proposal, it is said, is about to be made to the Chatham Company to lease the section in question for a term of years, re-equip it, and work it on shares; and the projectors believe that their offer to the company will be so tempting as to ensure serious consideration.

The Federated Institution of Mining Engineers. The annual general meeting of this institution was held last week at Hanley, Mr. W. N. Atkinson, H.M. inspector of Mines for North Staffordshire, occupying the chair. Amongst the "objects of interest" shown at the gathering were the following: "Best" miners' safety lamp, with electric lighting apparatus, by Messrs. Ackroyd and Best, of Morley, near Leeds; signal bells, electric signal bells, specially designed for colliery use (damp and dust proof); telephones for colliery work, safety lamps, with Messrs. Heath and Frost's patent paraffin burners; shaft and porch safety lamps, and various mining specialties, by Mr. H. M. Edwards, of Wakefield. At the conclusion of the meeting the members were divided into two parties—one visiting the electricity works at Hanley, where they were received by Mr. E. J. Hammersley, the Mayor, and Mr. Lobley, the borough engineer, the other going for a drive through Trentham Park.

Prof. S. P. Thompson and the Finsbury Technical College.—The evening classes at the Technical College, Finsbury, will shortly recommence, when the introductory lecture of the advanced course on electrotechnics (lighting and power) will be given by Prof. S. P. Thompson on rotating magnetic fields. The subsequent lectures of this course will be given by Mr. O'Keeffe and by Prof. Thompson, who will take up special topics, such as electric meters, design of alternate-current machinery, etc. The Wednesday evening course by Prof. Thompson and Mr. E. Thomas will deal with the current, its measurement and its application to the electromagnet, etc. There will be the usual practical classes in the laboratories, and Mr. E. Rousseau will later take a laboratory class on electrotyping and electro-plating. In the department of mechanical engineering, Prof. Perry will give on Thursday evenings, in addition to the ordinary course on practical mechanics, a short special course on thermodynamics as applied in engineering.

Westminster Street-Lighting.—There was a long and well-illustrated article on this subject in a recent issue of the *Westminster Times*, in which the present unsatisfactory state of the street-lighting was commented on. It is doubtless a fact that the lighting in many of the streets of Westminster is out of date and insufficient, but the author, in dealing with proposed improvements, should not neglect the arc lighting system. He carefully compares the cost for gas and electricity where the Welsbach burners and incandescent lamps respectively are used, and draws conclusions in favour of the gaslight. The proposed arrangement of using a group of 16-c.p. incandescent lamps for large streets has been condemned again and again by the technical Press as uneconomical. The author assumed a supply at 3d. per unit and arrived at a total cost of £9 per annum for such a group giving 48 c.p. If, on the other hand, he had tried arc lighting, he could for £27 have put in an arc lamp giving at least 1,000 c.p., which could replace a considerable number of small lamp-posts, and which would give a better light than gas, and also more economy, light for light.

Electrical Progress in India.—The debate on the Electric Lighting Bill in the Bengal Legislative Council was remarkable, says a correspondent, chiefly for a "learned" discourse on the development of electricity by the Honourable Mr. C. E. Smyth, which in a lecture-hall, and delivered to students, would no doubt have been highly instructive, but wedged into a debate in the Legislative Council was singularly out of place. How, the correspondent adds, it could benefit those anxious to understand the bearings of the Bill on the civil rights of the people to be told that "the development of electric science in its application to the practical needs of human life may be considered to date from the time of Faraday, whose career ended about the middle of the present century," it is hard to understand. A commencement has at length been made with the Colombo electric tramways, the terminus of which has been fixed opposite the Grand Oriental Hotel, and near the P. and O. offices. The General Post Office at Colombo was, moreover, lighted by electricity last month, and the effect of the new illuminant on the first night is described by a local paper as "grand."

Church Electric Lighting in England.—A correspondent who, we are glad to see, signs himself "A Regular Attendant," writes from Tunbridge Wells: "The electric light, having now been used for three Sunday evenings at Mount Pleasant Congregational Church, is pronounced by all the usual worshippers with whom I have come into contact to be an unqualified success; and seeing that other churches in the town are thinking of adopting this illuminant, it may not be out of place to say what the effect is in the pulpit, gallery, and pew. The Rev. Cowper Smith has given me permission to say that he, in every respect, has received the greatest possible comfort from the introduction of the light; in fact, he does not now feel more weary on the Monday than any other morning, and

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the light as arranged in the pulpit is practically perfect for reading purposes. The organist, Mr. Starmer, pronounces the light a great boon, and says that the pitch of the instrument holds good and in tune to the very end of the service without variation. The choir (which, with the organ, are situated in the gallery and opposite end to the pulpit) are more than satisfied with the extreme comfort of the evening services through the cool and pure atmosphere. The seat-holders, too, are well satisfied with the change."

Telephone Reform in France.—Telephonic communication will shortly be conducted under more favourable conditions in France. According to *L'Eclairage Electrique* of September 14, decrees have just been signed by the Minister of Posts and Telegraphs which will come into force on January 1, 1896, and which will remove from the Government regulations a number of provisions which hitherto served to harass the public and restrict the use of the telephone, to the detriment not only of the subscribers but to the finances of the State. The charge for conversations exchanged between two systems within a radius of 25 kilometres(16 miles), starting either from the house of a subscriber or a telephone office, will be reduced from 50 to 35 centimes. Similarly, the rate for a conversation over a single system, which in Paris and a great number of towns costs 50 centimes, is to be reduced to 25 centimes. The duration of a conversation will be limited to three minutes, statistics having shown that this was the average period at the higher price. The extension of the radius of communication at the reduced tariff (25 centimes) will, moreover, entail the suppression of the subsidiary systems, the existence of which has been the cause of so much complaint. These will henceforth cease to exist, both in the environs of Paris and in the departments, and all systems will be placed on the same basis.

The Telephone Service.—Following the conference at Halifax on the telephone service in the West Riding, a meeting of representatives of the Chambers of Commerce of Bradford, Leeds, Huddersfield, Wakefield, Dewsbury, Batley, Keighley, Morley, Birstall, and Cleckheaton has taken place at the Dewsbury Town Hall. The proceedings were private, but we understand that Mr. George Daniel Cullingworth, of Dewsbury, was elected to preside, and that Mr. A. Firth, of Halifax, reported what had taken place at the conference to the effect that the National Telephone Company's representatives said that it was impossible to make a reduction in the annual charge for instruments, and that as to trunk lines it had been suggested that the chambers of commerce concerned should endeavour to prevail upon the Postmaster-General to combine the areas of Bradford, Leeds, Dewsbury, Wakefield, Halifax, and Huddersfield into one, the wires to be local and not trunk lines. This was approved, and it was agreed to memorialise the Postmaster-General and to ask him to receive a deputation on the subject, the meeting in the meantime being adjourned.—The Postmaster-General's report with regard to telephones says: "The negotiations with the National Telephone Company respecting the areas within which the operations of the company are for the future to be restricted and for the settlement of an agreement for carrying into effect the policy set forth in the Treasury minute of May 23, 1892, have been brought to a conclusion, and the drafts of the formal agreements with the licensees were laid on the table of the House on August 7 last. The total amount spent out of the million authorised by the Act of 1892 was £355,678 at the end of the financial year."

Electricity and Fires.—Mr. William McDevitt, chief of the electrical department of the Philadelphia Underwriters' Association, lately gave an illustration of some of the ways in which fires may be caused by electricity. The first danger, he said, was that arising from the common practice of grounding telephone wires on gas-pipe. A bad connection is generally made—quite sufficient for telephone purposes—and, if the telephone wire be crossed with an electric light wire, the larger current meeting resistance at the ground connection heats the joints, punches a hole in the gas-pipe, and the arc formed lights the gas. Mr. McDevitt gave a demonstration of the gas and insulation on the wire burning simultaneously. He also exhibited a section of gas-pipe that had caused a fire in this way. The wires in the sockets of electric lamps are liable to touch the casing, when an arc may be formed. For this reason no drapery should be used around the lamp sockets. The advantage of utilising metal conduits with insulated lining through which to run the wire was shown, a wire outside being dangerously heated, while from that inside the conduit there was no risk. A caution was given against the rough handling of flexible cords used for electric lights as a common cause of short-circuits and fire. There were, he remarked, other dangers due to ignorance on the part of the general public of the character of the electric current. In one case on record the walls of a room were upholstered with material in which were interwoven a large number of metal threads. These were in contact with the electric light wires, and when the current was turned on the whole room was set ablaze. An obscure danger from frictional electricity has been traced. Sparks may be caused by shuffling the feet on carpet or by the rubbing of silk. Where benzene is used to clean such materials, a spark thus caused may give rise to a dangerous fire. It is believed that some benzene fires have originated in this manner. Another cause of fires is the unreliability of fuses. They are put in the line to be burnt out when an excessive current is turned on, but, like safety-valves, they do not always work. If they fail to fuse, a dangerous current may be carried along the line. To obviate this danger, Mr. McDevitt added, a standard should be adopted.

Prof. Fleming on Increased Supply Pressure.—Prof. J. A. Fleming, writing from the Electrical Engineering Laboratory, University College, W.C., contributes his quota to the St. Pancras discussion, which is reproduced in another column. He says: "The discussion on the subject of increased pressure for the electric supply and some possible objections to it has a very practical side to it. The public electric supply has up to now been given in London and most provincial towns either by the alternating-current system, in which the electric energy is delivered at a high pressure to transformers, placed in the houses or in certain special localities, by which it is transformed down to currents of lower pressure for delivery to customers, or by the continuous-current three-wire system, in which a certain electric pressure, generally of 100 or 110 volts, is maintained between the intervals of three insulated conductors laid in the ground. If, for simplicity, these three conductors are called A, B, and C, theoretically there should be 100 volts pressure between A and B and 100 between B and C, and all three should be insulated from the earth. As a matter of fact, it is difficult for the supply companies using mains of a certain type to preserve perfect insulation all over their systems of conductors, and if one of the outer conductors, say C, becomes earthed, the other outer conductor, A, will be raised to a pressure of 200 or 220 volts above the earth. All electric fittings used in houses, such as lamp sockets, switches, motors, and the like, are, even on the present systems of electric supply, exposed to the chance of

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having to bear an electric pressure of 200 or 220 volts between some portions of them, and ought all to be so made and tested that they can stand this pressure safely. The question has been much debated whether there would be advantage or disadvantage in earthing the middle wire of the three-wire systems of supply; but it is clear that if any of the three-wire systems of electric supply propose to give a 200-volt pressure between each side of the system, making 400 over all, a more severe system of inspection and testing of ordinary house electric fittings will have to come into force. If, on the other hand, it is merely intended to extend in London the outer members of the three-wire system of conductors and to use 200-volt lamps in these outer districts of the supply area, then the state of affairs, electrically speaking, will be no worse than it is at present."

Technical Education.—Nowhere in Great Britain, apparently, is so much attention devoted to the very important subject of technical education as in Liverpool and its suburbs, where both the Earl of Derby and Sir A. B. Forwood, M.P., have recently been expatiating on the theme. Lord Derby, who was present at the distribution of prizes to the successful students of the Liverpool School of Science, Technology, and Art during the past session, remarked that "science is now diffused through the length and breadth of the land, and ample response is being given to the noble manner in which municipalities made grants for technical education purposes." Sir A. B. Forwood, in opening the session of the Waterloo Technical Instruction Classes the other day, remarking on the facilities afforded by towns for technical education, said that Birmingham was spending £50,000 on a central institution; Manchester, £130,000; Salford, £55,000; a poor place like West Ham, in the East of London, £40,000; Wigan, St. Helens, and Derby, £20,000 each; whilst Liverpool was having plans prepared which contemplated an outlay of £80,000. Again, at the annual award of prizes to students attending the classes of the Technical Instruction Committee of the Wavertree District Council, Mr. J. N. Stolterfoht said that a class in electricity would be commenced, and that he hoped that the committee would find this experiment a success, because if technical instruction were to be given, it should be in those things which were applicable to every-day life. The chemical class, he observed, had been a failure, and this was to be regretted, as chemistry and electricity were the two great motive powers, the great subjects of study for the improvement, he might say, of science and art in the present day; and on that account he trusted that the electricity class would be successful. Finally, so far as Liverpool is concerned, at the yearly distribution of prizes to the students of the Toxteth Park Technical Instruction Committee, it was stated, on the authority of Principal Rendall, that higher technical education at University College had been invaluably reinforced, and that an entirely new department in electrical technology had been created and maintained. The school of art in Mount-street had, moreover, been placed in a sound financial position, and the first school of architecture and the applied arts in the United Kingdom had been founded. Other centres of population are, of course, also doing excellent work in the direction of scientific education. We note especially that electric lighting now forms one of the subjects taught at the Heriot-Watt College, Edinburgh, in addition to the stereotyped electricity and magnetism and telegraphy and telephony.

Electrical Interference.—Two methods of avoiding or overcoming electrical interference were discussed by Mr. Abbott in his paper, recently read before the North-Western Electrical Association at Chicago — namely, complete metallic circuits, and the introduction of special return feeds from dangerous points. In his paper on "Additional Solutions of the Electrolytic Problem," Mr. Abbott further considers this important subject. To begin with, he disposes of the suggestion that corrosion could be avoided by operating the railway circuit as a three-wire system, pointing out, first, that a double track is essential, so that the trolley wires may serve as the outer mains, while the ground and the rails play the part of the neutral wire. Of course, this of itself would make the expedient unsatisfactory, as it would exclude all of the many single-track installations from consideration. Another objection is that it would be impracticable to arrange the load on the two sides of the railway to a complete balance, and in so far the system is out of balance the current must return through the rails and ground. Besides, as the load on the two sides of the system is constantly varying over the entire length of the road, the current in the neutral conductor will correspondingly vary, and will in this way spread the injury to underground structures over a much larger territory, and render it impracticable at any time to determine where injury is about to take place. Mr. Abbott considers Mr. Brown's arrangement of station machinery a partial solution of the problem, but he does not look upon it as a complete cure. A plan proposed by Mr. Farnham is accepted with favour by Mr. Abbott, but he does not hesitate to show his belief that it will be rejected by railway companies, owing to the expense which the system entails. He reminds the managers of railway companies, however, that it merely remains for them to face the inevitable position that they must either design railway lines in such a manner as to obviate the damage to existing underground structures, or to go out of the business. In conclusion, he points out that it is absolutely certain that the time is rapidly approaching, if it be not already at hand, when no franchises will be granted to electric railway companies that do not contain a provision fixing upon the railway companies all responsibility for injury which may later be attributable to electrolytic action. He reminds them that in many instances the damage done by existing railway companies has formed a basis for legal proceedings, in every instance to the defeat of the railway company, and he admonishes them to look the situation squarely in the face and take such steps as in the future will relieve them from disagreeable responsibilities of this kind. He concedes to the telephone companies no privileges or advantages not enjoyed by the railways, and he insists that responsibility for damages be placed wherever it belongs. The full paper is printed and illustrated in the *Western Electrician* of August 31.

Compounding Dynamos for Armature Reaction with Converters.—Since the paper by Prof. Elihu Thomson was read before the meeting of the American Institute of Electrical Engineers, at Niagara Falls, on the subject of compounding dynamos for armature reaction, there has been some discussion among electrical engineers regarding the early history of the theme. A representative of a Chicago journal recently had an interview in Boston with Dr. W. P. Freeman, who made deep researches into this matter in the pristine days of electrical invention. Dr. Freeman was asked to state, as nearly as possible, when he was able to present a practical demonstration of the converter system, and he replied: "In 1881 I perfected a machine on a principle of a compound dynamo for armature reaction which produced five arc lights or 40 incandescent lights, and I used in circuit a pole-changer and induction coils, or converters, as is better known at the present time. When the incandescent lights were used the machine delivered 2,500 volts and 15 amperes. There were two converters, each about 12in. in length, and I connected these two in

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multiple circuit, and dropped the voltage, as I remember, to either 50 or 75 volts, and ran 40 incandescent lamps, a part of which were Maxim, with a filament often called 'M' or 'W.' I had this on exhibition for three months or more at my factory, 43, Center-street, New York City. A large number of capitalists came in during that time to investigate the system, and I finally made an arrangement, and sold to W. F. Jobbins, of New York City, what was known at that time as the sub-dividing device of the electric light system, reducing a high voltage to any required voltage, and which was supposed at that time and talked of as being a wild idea, and Mr. Jobbins did not consider it of much importance. I therefore added to the same agreement the sale of the thermostat invention, which I was manufacturing, for one-fifth interest in the Jobbins Manufacturing Company's Works. In 1883 I constructed two machines, one a direct-current machine and the other an alternator. These machines were practically the same as the machine I made in 1881, except the variations which were made to facilitate winding, and also to bring about a more perfect and even saturation of the magnetic flux. During that year I sold upwards of 20 of this type of machines, which were much smaller than the first two manufactured, but which produced 20 incandescent lights of 16 c.p. In 1886 I made still a further improvement upon the previous design, since when I have manufactured several hundred small machines, and on March 27, 1888, I received a patent, No. 268,737, which proves to my satisfaction that these are the fundamental principles of this system as claimed by me; and according to my patents I do not see where a multipolar-field machine can be used where only one-half of the pole-pieces are wound, without infringing upon my patent. One of the claims allowed me was 'the combination of a multipolar field magnet and multipolar iron armature corresponding in number of arms, or polar extensions, and having only half its total number of arms wound with generating conductor and commutator.' I do not consider this machine as an emergency machine, but one which is practical from every standpoint, as it can be made in all sizes, and will govern itself within 2 per cent. with a variation in speed of the armature of at least 10 per cent. without overheating."

A Year of British Telegraph Work.—According to the report of the Postmaster-General on the operations of the Department for 1894-95, during the year under review 71,589,064 telegrams of all kinds were forwarded in the United Kingdom, being an increase of 689,566, or 97 per cent. Of these, 58,907,408 were ordinary inland messages, while 5,937,715 foreign telegrams were dealt with, being an increase of 255,890; but there was, it should be noted, a decrease of 178,905 in the number of Press messages. The deficiency on this Department during the year amounted to £452,803, compared with £477,327 in the previous year. The postal and telegraph services together showed an increase of £341,000 in receipts and of £274,000 in expenditure, or a financial improvement of £67,000. The whole chapter of the telegraph service is, however, a critic says, manifestly rather a sore subject with the Post Office, which still chafes under the financial burden imposed on it by the original purchase of the telegraphs. The development of business has been extraordinary. In 1870-71, the first year after the transfer of the telegraphs to the State, the number of telegrams forwarded throughout the United Kingdom was 9,850,000. It gradually rose to 39,140,000 in 1885-86—the year in which, on October 1, 1885, the minimum charge for an inland telegram was reduced to 6d. In the following year it exceeded 50,000,000, and it now stands at over 71,500,000. Not less remarkable is the progress attained in efficiency and rapidity of transmission. One of the appendices to the report contains a brief "Historical Outline of the Telegraph Service since 1870." In this it is stated that "in 1870 a speed of from 60 to 80 words a minute was the highest that could be attained in the working of the Wheatstone automatic apparatus. At the present time a speed of 600 words per minute has become possible, and the working speed of 400 words is the fixed standard for certain circuits. . . . Two copper wires between London and Dublin are working on the duplex system at even 300 words per minute, whereas under the conditions of 1870 they would only have given about 40 words in one direction as a maximum." These and similar results are cited by the Post Office as a sufficient answer to the contention urged at the time of the transfer that the possession by the Government of a monopoly would tend to discourage invention. Many of the improvements resulting in the present rapidity of transmission have been adopted from outside, but many others have been devised within the Department, and it must be acknowledged that the Post Office is now probably one of the best schools of practical telegraphy in the world. But the financial results of this remarkable progress are considerably less satisfactory. In 1888-89 the receipts from telegraph business were £2,129,965, and the expenditure was £2,041,261; but as the annual interest on capital expended was £353,787, the resulting deficit was £265,183. In 1893-94 the receipts had risen to £2,579,206 and the expenditure to £2,757,645, while the interest on capital had fallen to £298,888, thus showing, as we have already seen, a deficit of £477,327. In 1894-95 the interest on capital was the same as in the previous year, but the receipts increased in a slightly larger proportion than the expenditure, and the deficit was thereby reduced to £452,803. Thus it appears that in the last seven years the expenditure has gradually risen in excess of receipts, so that whereas in 1888-89 there would have been a small surplus of receipts over expenditure, independently of the amount charged as interest on capital, there is no such surplus in 1894-95, but a deficit of £153,915, which, added to a charge of £298,888 for interest on capital, makes up the total deficit of £452,803. It is true that the deficit of the previous year was £25,000 larger, but, the critic remarks, it is far from satisfactory to find that, even if the interest on capital could be finally wiped out, the telegraph service would still be worked at a loss. In 1888-89 the number of telegrams was 57,765,347. The receipts from these were, as we have shown, £2,129,965, and the expenditure was £2,041,361. In 1894-95 the corresponding figures were—number of telegrams, 71,589,064; receipts, £2,675,414; and expenditure, £2,800,329. Thus, while the number of telegrams has increased by a little under 24 per cent. and the receipts by a little over 24 per cent., the expenditure has simultaneously increased by no less than 37 per cent. This result is due to various causes, among which the low rate at which Press telegrams are transmitted—practically not more than 4½d. for 100 words—is credited with a loss estimated at £300,000 per annum. "Moreover," the appendix to the report says, "new influences inimical (temporarily, if not permanently) to financial success have come into play—namely, the reduction of the tariff in 1885, the increase in the pay of the staff, and the competition of the telephone companies for local traffic." For the rest there is no little force in the concluding paragraph of the appendix already quoted: "The Post Office has to admit a deficit on the working of the telegraphs, but its 71,000,000 telegrams bear testimony to the value of the service which it renders to the public."

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AN IMPROVED PORTABLE PHOTOMETER.*

BY W. H. PREECE, C.B., F.R.S., AND A. P. TROTTER, B.A., A.M.I.C.E.

When light falls upon a surface that surface is said to be illuminated. The illumination depends simply upon the light falling upon the surface, and has nothing to do with the reflecting power of the surface, just as rainfall is independent of the nature of the soil. As a rain-gauge receives the full amount of rain when it is placed horizontally, disregarding wind, and receives less when it is tilted, so a surface is fully illuminated when it faces the source of light, and is less fully illuminated when the light falls upon it at an angle. The proportion between the full rainfall or illumination and the measured rainfall or illumination varies as the cosine of the angle of incidence of the rain or of the light. This angle is 0deg. and the cosine is 1 when the rain-gauge is placed horizontally or when the light falls perpendicularly upon the surface. It would perhaps be unnecessary to call attention to these very elementary matters were it not that difference between the photometry of illumination and the ordinary photometry of candle-power is often confused.

The lighting of streets and of buildings may be specified by the maximum and minimum illumination. The primary purpose of an illumination photometer is to measure the resulting illumination produced by any arrangement of lamps, irrespective of their number, their height, or of their candle-power. Illumination photometers containing sub-standards of light have been designed by Prof. Weber,† Prof. Mascart,‡ and others. One of us described an illumination photometer before the Royal Society in 1883.§ This consisted of a box blackened within. Over the end was stretched a Bunsen screen of paper, on the middle of which was a grease spot. At a distance of 12in. was another screen of drawing paper. The grease spot was so screened that no light fell upon it, except that which was reflected from the drawing-paper screen. At the end of the box opposite the Bunsen screen was an eyepiece, consisting of a plain tube, within the box a small incandescent lamp was fixed, and in order to make a measurement of the illumination of the drawing paper screen, the current through the lamp was varied through a rheostat until the grease spot was invisible. The readings were recorded in luces, a lux being suggested by one of us at the Paris Electrical Congress, 1889, as the name for the illumination due to a carcel lamp at one metre, and equivalent to a British standard candle at 1·058ft. The only defect of this photometer was the yellowish and reddish colour of the lamp when dimmed for low readings.

In 1884 we designed a portable photometer,‖ in which the lamp could be moved towards or withdrawn from the Bunsen screen, and a mechanism was provided by which, when a pointer moved a certain distance over a uniformly divided scale, the displacement of the lamp was as the square of that distance. The Bunsen spot was viewed by Rudorff mirrors in the usual way. This instrument worked well, but the range was small, and could not be easily increased. The lamp would have to be moved to a very considerable distance from the screen for measuring the feeble illuminations met with in street-lighting.

Eight years later, one of us experimented with modifications of this instrument, and found that in ordinary street-lighting the illumination is often only equal to that due to one candle at 14ft. distance. A large number of different methods of reducing the light were tried. Many combinations of lenses, the eclipsing device used in dissolving views, photographically shaded glass screens, and other devices were used, and, finally, a white reflecting screen was inclined at different angles to a small electric lamp, and on this principle a photometer was constructed in February, 1892. It was found that the Bunsen screen could be replaced with advantage by a simple white cardboard diaphragm pierced with one or more holes.* The illumination of this diaphragm, generally in a horizontal position, was the illumination to be measured. Below this was the reflecting screen, enclosed in a box about 2ft. × 6in. × 5in., with a pair of small glow lamps and a secondary battery. The screen could be inclined towards the glow lamps by means of a chain wound up on a cam mounted on a spindle, the cam being formed so as to give an open scale. A hand, or pointer, indicated readings on a dial. Many measurements and a number of photometrical surveys of different streets and public buildings in London were made in 1892, and are recorded by means of plans with isophotal contour lines and otherwise.†

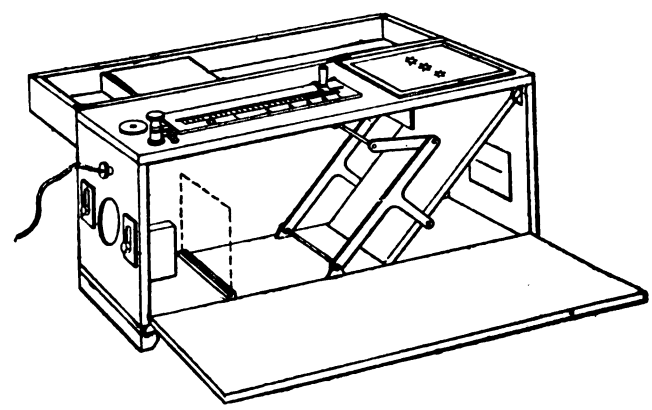

FIG. 1.

During the present year an improved form of this photometer has been constructed. The chain and cam, which allowed the instrument to be used only in a horizontal position, have been replaced by a system of levers. The object of these levers is to give an open scale. If the motion of the pointer were proportional to the angular movement of the screen, the scale would be approximately a scale of cosines. The instrument is shown in Fig. 1 with the lid open and the front let down. It measures 1ft. 3½in. by 5½in. by 9½in. high (400mm. × 140mm. × 242mm.). On the end to the left there is a red glass window, and immediately within are two 12-volt lamps (one of which is shown in Fig. 2), one of about 1 c.p., and the other of 2 c.p. It can be seen through the window if either or both of the lamps are alight. The lamps are held in special lamp-holders, capable of adjustment as to height by clamping screws. These clamping screws and the base of one of the lamp-holders are shown in Fig. 1. A switch on the top of the instrument enables either or both of the lamps to be turned on or off. At the other end of the box the reflecting screen is hung. The middle of the screen is about 11in. (28cm.) from the lamps. It is shown in Fig. 1 in its lowest position. In Fig. 2 the screen and one of the levers, together with one of the rollers on which the screen

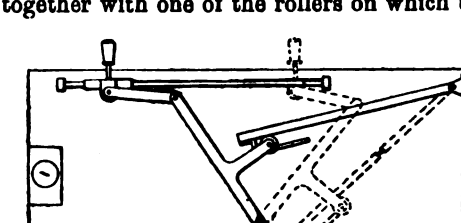

FIG. 2.

rests, and the handle by which it is moved, are shown with the screen in its highest position by full lines, and in its lowest position by dotted lines. In its highest position the filaments of the lamps are a little below the plane of the screen, no direct light from the lamps then reaches the screen, and is only faintly illuminated to about $\frac{1}{200}$th of one candle at a foot, by stray light, which is excluded as much as possible.

The diaphragm is placed horizontally immediately above the hinged screen. Three small star-shaped holes are cut in and through them; the illuminating reflecting screen can be seen. A handle carrying a pointer, moving over a graduated scale, controls the inclination of the screen by means of the levers and links. A guide attached to the back of the screen

* Paper read at the meeting of the British Association at Ipswich.

† *Elektrotechnische Zeitschrift*, 1884, p. 166. *La Lumière Electrique*, vol. xii., p. 468.

‡ *Bulletin* de la Soc. Inst. des Electriciens, 1888, p. 103.

§ *Proceedings* Royal Society, xxxv., p. 39, 1883, and *Proceedings* Inst. C.E., vol. cx., p. 98.

‖ *Proceedings* Inst. C.E., vol. cx., p. 101.

* *Proceedings* Phys. Soc., xii., p. 355, 1893.

† *Proceedings* Inst. C.E., vol. cx., pp. 42-51.

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(shown in Fig. 2) allows the instrument to be turned on its side without interfering with the working. In order to take a measurement, one or both of the lamps are turned on, and the handle is moved until the screen seen through the holes in the diaphragm matches the diaphragm in brightness. If the colour of the light outside is about the same as that of the lamps, the middle hole may be made to disappear. The observer should stand approximately in the vertical plane passing through the three holes, so that he may see that part of the screen through them which lies immediately beneath them.

Various substances have been tried for the diaphragm and screen. Thin metal painted with a whitewash made of magnesia and isinglass is perhaps the best. The diffused reflection practically follows Lambert's cosine law, but the material is easily soiled and cannot be cleaned. Bristol board, from which the glaze has been removed by a damp cloth, closely follows the cosine law within the angular range required in this case. It is important that there should be no glaze on the surface of the hinged screen, since the inclination of the lamp to the screen, and of the screen to the eye for maximum illumination, is about 45deg. But as the scale is graduated by experiment, a slight departure from the cosine law does not matter. On the other hand, it is of greater importance that the screen should be very smooth and flat. Under very feeble illuminations the light from the small lamp, making an angle of incidence very nearly 90deg., minute irregularities are easily seen, and make accurate readings difficult. For ordinary street-lighting and for general industrial photometry, a slight departure from the cosine law on the part of the diaphragm is of no practical consequence, so long as there is no perceptible glaze, for it is always observed nearly vertically and never at a large angle.

The colour difficulty is reduced, in the first instance, by the freedom of motion of the levers. The handle may be quickly moved to and fro on each side of the true reading, and the middle position may be estimated. In measuring the illumination due to arc lamps, the colour difficulty becomes troublesome. The colour of the incandescent lamp in the photometer should be approximately a mean between the colour of the standard of light wherewith the instrument is calibrated, and that of an arc lamp. This halves the difficulty which can never be entirely removed, since differently-coloured lights are not physically comparable. It may, however, be relegated entirely to the laboratory by the use of a coloured screen and diaphragm.

If the hinged screen be tinted pale blue, some of the yellow rays of the lamp in the photometer are absorbed, and the reflected rays approximate to grey—that is, to feebly illuminated white. On the other hand, if the diaphragm is tinted yellow, the white light from electric arcs or of daylight may be reduced to approximately the same colour as that of the lamp in the photometer. In the first case the brilliance of the hinged screen is reduced, and a brighter lamp would have to be used to restore the true value of the scale readings; and in the second case the brilliance of the diaphragm would be reduced, and the scale readings would be too high; but by tinting both screens the calibration of the instrument need not be disturbed. The screen being coloured pale blue and the diaphragm pale yellow there is no difficulty in obtaining disappearance of the hole in the diaphragm when illuminated by arc light or even by daylight. The selection of the colours suitable for obtaining a true measurement is based upon the mean of a number of measurements. White screens are used, and the comparison should be made in a building illuminated with a number of arc lights. A number of measurements are made with quick oscillations of the handle, and the mean is taken. Several screens and diaphragms of different tints being in readiness, pairs are tried, and a selection is made of a pair which give a good colour match,* and, if possible, the mean reading given by the white screens. A slight departure from the mean could be corrected by the use of a coefficient. It is not suggested that strongly-coloured lights can be scientifically compared in this manner, but only that the yellowish light of an incandescent lamp may be compared with the whitish light of an arc or of subdued daylight. We employed this device in 1884, and Messrs. G. W. and M. R. Patterson, the translators of Palaz's "Industrial Photometry," who have used it in connection with a Lummer-Brodhum photometer, remark* that "it can, of course, give no additional absolute accuracy to the photometric measurements; it, however, adds greatly to the comparative accuracy of the results, as it makes it possible to measure relative intensities under various conditions with great precision." But it should be observed that the selection of the tints may be made at leisure, and under favourable laboratory conditions, and by thus avoiding all colour trouble during ordinary use of the photometer, a very considerable gain in precision is secured.

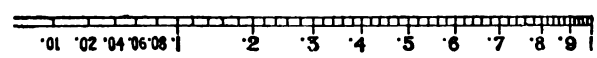

FIG. 3.

The scale is 5½in. (137mm.) long, and is shown in Fig. 3. With the smaller of the two lamps the highest reading is equivalent to one candle at a foot, with the larger lamp it is twice this illumination. The oscillations of the handle generally extend at first over two scale divisions, and after three or four oscillations their amplitude may be reduced to about one scale division. The half of a scale division may be estimated except at the highest part of the scale, which is slightly contracted. The precision is about 2 or 3 per cent. The contraction of the upper part of the scale is intentional, and is caused by the arrangement of the levers.

In case of renewal of the lamps, it is very important that other lamps should be placed in exactly the same optical position in the photometer; otherwise the scale would have to be recalibrated. In order to fix the height of the lamps, which is the only adjustment necessary, a sheet-metal screen, shown by dotted lines in Fig. 1, is placed in a holder attached to the floor of the photometer. Two small holes are drilled in this screen, and a white paper screen having a black horizontal line is fastened to the end of the box (see Fig. 1) opposite to the lamps. The hinged screen being lifted by the levers out of the way, "pinhole images" of the filaments are thus thrown on to this screen, and the lamps being set (see Fig. 2) so that the single horseshoe filament appears nearly closed up, the dark line between its two limbs is made to fall on the black horizontal line. The images being magnified, considerable accuracy is possible.

Although the principal object of this photometer, as of those which preceded it, is the measurement of illumination, it is sometimes desirable to measure the candle-power of a lamp in the street without removing it from its position. By the use of a graduated arc, such measurements can be made with the present photometer. A quadrant is fastened to the side of the photometer, and a pin at the centre, from which the quadrant is struck, acts as a gnomon. A spirit-level on the top of the instrument being adjusted, the angle of incidence may be read in degrees on the quadrant, and at the same time the cosine of this angle may be read on an adjacent scale. It is necessary to find the slant height or direct distance from the source of light to the photometer.

To measure the vertical height of the light, set the photometer so that the shadow falls on 45deg. Measure the distance from the pin to the lamp horizontally, and from the pin to the ground vertically. The sum of these distances is the height of the actual source of light. This can be measured to about 2 per cent.—say, 3in. in 12ft. 6in. To find the slant height at any distance, the height of the light being known, divide the height of the lamp above the photometer by the cosine of the angle of incidence, the quotient is the slant height required; or the horizontal distance may be measured, and the square of this distance added to the square of the height of the light. This gives the square of the slant height. To find the candle-power, the illumination in units of a candle at a foot being observed, the light from other lamps being carefully screened, the slant height being known. Multiply the

* Owing to the Purkinge effect, an exact colour match cannot be maintained throughout the whole range. The holes in the diaphragm look yellowish under strong illumination, and bluish under feeble illumination.

* "A Treatise on Photometry," Palaz, American translation, Appendix, p. 312.

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illumination by the square of the slant height, and divide by the cosine of the angle of incidence.

On hilly ground it is necessary to know the height of the lamp above the photometer at each point of measurement. It is best, in that case, merely to record the angles, and afterwards to find the tangents. The horizontal distance between the photometer and the lamp-post, divided by the tangent, gives the required height.

It may be observed that when the square of the slant height in feet is equal to the cosine of the angle of incidence, the scale graduated in units of a candle at a foot becomes a scale of candle-power, and when the square of the distance in feet is 10, 100, or 1,000 times the cosine, the multipliers 10, 100, or 1,000 may be used to convert it into a scale of candle-power. The square of the slant height being known, the photometer may be tilted until the required cosine is indicated by the shadow of the pin. If the slant height is measured by the sum of the squares of the horizontal distance and of the height, the square is at once obtained.

We have calibrated our photometers, either by standard candles or by sub-standard incandescent lamps supplied from secondary batteries, or by the amyl-acetate standard lamp or Hefner unit. This standard, which is well recognised in physical work, is 0·877 of a standard cable, or a standard candle is 14 per cent. more than an amyl-acetate lamp. Placed at 1ft. distance from, and perpendicular to, the diaphragm, the photometer being placed on its side, the illumination is 0·877 of a candle at a foot. If it is brought to a distance of 11¼in. ($\sqrt{0{\cdot}877}$ft.), it is equivalent to one candle at a foot. But this distance and position is inconvenient. If it is placed at a distance of 1ft., and at an angle of incidence of 55° 10′, the illumination on the diaphragm is one-half of a candle at a foot, since cos 55° 10′ = ·57 and ·57 × ·877 = 5. A mark is therefore made at this angle on the quadrant, and is inscribed H.U. = ½ c.p. Considerable experience with the use of small incandescent lamps supplied from portable secondary batteries has given us great confidence in this kind of secondary standard of candle-power. The battery is always freshly charged before each evening's work, and is discharged for half an hour before use. The lamps are only turned while an observation is being taken.

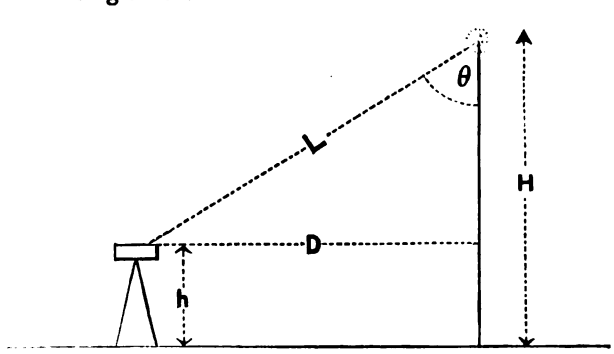

FIG. 4.

The 1883 photometer was arranged to be held in the hand; our 1884 photometer stood on a tripod about 2ft. 6in. from the ground. The street measurements made in 1892 were all made with a photometer placed on the ground, the diaphragm being about 6in. from the pavement. The proper height for an illumination photometer is a matter of opinion. When the photometer is placed on the ground, the large number of measurements required for a thorough photometric survey of a street or empty building can be quickly made. For some purposes—for example, an exhibition or a church—a stand is necessary; the calculations of candle-power become rather more tedious.

The various observed and computed quantities may be expressed as follows (see Fig. 4):

D = horizontal distance from photometer to lamp-post;
L = slant height from photometer to light;
H = height of light above the ground;
h = height of the photometer diaphragm from the ground;
θ = angle of incidence;
cf^2 = illumination of units of a candle at a foot;
$c.p.$ = candle-power.

$$H - h = D \div \tan \theta.$$

$$L = (H - h) \div \cos \theta.$$

$$= \sqrt{D^2 + (H - h)^2}.$$

$$c.p. = \frac{cf^2 + L^2.}{\cos \theta.}$$

The following is an example of the measurement of the illumination and candle-power in the case of a street lamp:

D	θ	cf^2	tan θ	cos θ	H − h	H	L	L^2	$cf^2 \times \cos \theta$	$c.p.$
20	66°	0·025	2 25	0·407	8·9	11·9	21·8	475	0 0614	29

NOTES ON THE LOCAL ORIGIN OF THE AURORA BOREALIS.*

BY W. H. WOOD.

The author found that calculations based on the cosmical theory of the aurora borealis gave results inconsistent with the facts of observation by placing the objects at such great distances from the observers as to preclude the light from reaching them. Also he found that the streamers do not show any variation in angular amplitude, nor in the intensity of the light at the various observing stations however distant or near to the assumed region of verticality, but the objects, on the contrary, present the same appearance as to distance from each and all those places. It is often objected against these facts that the observations are not carried out scientifically. It can be shown, however, that a display of aurora borealis is formed in a number of centres over a given tract of country. The various auroral figures constitute local groups having many features in common, but which can be differentiated, and their identity disestablished by the presence of a physical order of differences permeating the group and by the variable factors. A comparison of the radiant points of the streamers obtained from a set of observations, will show a remarkable difference in the amount and in the direction of the inclination of the streamers at each place of observation, proving the distinct group. Again, the time of maximum phase has been observed to travel across England from the east coast to the coast of Ireland in 2½ hours, the earliest phase commencing at the east coast and falling 10 minutes later in a series of successive stages across the country. The time of maximum phase at one place has been found to coincide with the time of minimum phase at another, maximum being defined as the period of the greatest number of auroral figures in sight, and the minimum phase marking a period of their absence. An ocular proof of the above was stated as follows: An auroral object visible in Manchester failed to be simultaneously seen at Birmingham, and also could not be seen 5½ miles north of Birmingham. The streamers also vanish under telescopic view, indicating dispersed points of light near at hand. Clouds and rain usually follow displays of the aurora, as reported from all stations. This the author considers due to electrical discharges. As an experiment in support of this, if a column of steam has its shadow cast on a whitewashed wall, and a current of electricity is passed through the steam, the shadow will be noticed to deepen and assume an orange-brown colour. This change is due to the coalescence of the minute particles of the water in the vapour. This is analogous to the change effected in the rain-clouds region by the aurora. Spectroscopic examination of the aurora shows indices of oxy-hydrocarbonic acid gas and argon corresponding to an electrical condition of moist air.

The author concludes that the plane of illumination is at right angles to the direction of the horizontal current, the plane being illuminated on the south side only in these northern latitudes.

* Abstract of paper read at the meeting of the British Association at Ipswich.

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PRESIDENTIAL ADDRESS TO THE BRITISH ASSOCIATION.

BY SIR DOUGLAS GALTON, K.C.B., D.C.L., F.R.S.

(Concluded from page 289.)

Physics.—If we turn to the sciences which are included under physics, the progress has been equally marked. In optical science, in 1831, the theory of emission as contrasted with the undulatory theory of light was still under discussion. Young, who was the first to explain the phenomena due to the interference of the rays of light as a consequence of the theory of waves, and Fresnel, who showed the intensity of light for any relative position of the interference waves, both had only recently passed away. The investigations into the laws which regulate the conduction and radiation of heat, together with the doctrine of latent and of specific heat, and the relations of vapour to air, had all tended to the conception of a material heat, or caloric, communicated by an actual flow and emission. It was not till 1834 that improved thermometrical appliances had enabled Forbes and Melloni to establish the polarisation of heat, and thus to lay the foundation of an undulatory theory for heat similar to that which was in progress of acceptation for light. Whewell's report, in 1832, on magnetism and electricity shows that these branches of science were looked upon as cognate, and that the theory of two opposite electric fluids was generally accepted. In magnetism, the investigations of Hansteen, Gauss, and Weber in Europe, and the observations made under the Imperial Academy of Russia over the vast extent of that empire, had established the existence of magnetic poles, and had shown that magnetic disturbances were simultaneous at all the stations of observation. At their third meeting the association urged the Government to establish magnetic and meteorological observatories in Great Britain and her colonies and dependencies in different parts of the earth, furnished with proper instruments, constructed on uniform principles, and with provisions for continued observations at those places. In 1839 the British Association had a large share in inducing the Government to initiate the valuable series of experiments for determining the intensity, the declination, the dip, and the periodical variations of the magnetic needle which were carried on for several years, at numerous selected stations over the surface of the globe, under the directions of Sabine and Lefroy.

In England systematic and regular observations are still made at Greenwich, Kew, and Stonyhurst. For some years past similar observations by both absolute and self-recording instruments have also been made at Falmouth—close to the home of Robert Were Fox, whose name is inseparably connected with the early history of terrestrial magnetism in this country—but under such great financial difficulties that the continuance of the work is seriously jeopardised. It is to be hoped that means may be forthcoming to carry it on. Cornishmen, indeed, could found no more fitting memorial of their distinguished countryman, John Couch Adams, than by suitably endowing the magnetic observatory in which he took so lively an interest. Far more extended observation will be needed before we can hope to have an established theory as to the magnetism of the earth. We are without magnetic observations over a large part of the southern hemisphere. And Prof. Rücker's recent investigations tell us that the earth seems, as it were alive, with magnetic forces, be they due to electric currents or to variations in the state of magnetised matter; that the disturbances affect not only the diurnal movement of the magnet, but that even the small part of the secular change which has been observed, and which has taken centuries to accomplish, is interfered with by some slower agency. And, what is more important, he tells us that none of these observations stand as yet upon a firm basis, because standard instruments have not been in accord; and much labour, beyond the power of individual effort, has hitherto been required to ascertain whether the relations between them are constant or variable.

In electricity, in 1831, just at the time when the British Association was founded, Faraday's splendid researches in electricity and magnetism at the Royal Institution had begun with his discovery of magneto-electric induction, his investigation of the laws of electro-chemical decomposition, and of the mode of electrolytical action. But the practical application of our electrical knowledge was then limited to the use of lightning-conductors for buildings and ships. Indeed, it may be said that the applications of electricity to the use of man have grown up side by side with the British Association. One of the first practical applications of Faraday's discoveries was in the deposition of metals and electroplating, which has developed into a large branch of national industry, and the dissociating effect of the electric arc for the reduction of ores, and in other processes, is daily obtaining a wider extension. But probably the application of electricity which is tending to produce the greatest change in our mental, and even material condition, is the electric telegraph and its sister, the telephone. By their agency not only do we learn, almost at the time of their occurrence, the events which are happening in distant parts of the world, but they are establishing a community of thought and feeling between all the nations of the world which is influencing their attitude towards each other, and, we may hope, may tend to weld them more and more into one family. The electric telegraph was introduced experimentally in Germany in 1833, two years after the formation of the association. It was made a commercial success by Cooke and Wheatstone in England, whose first attempts at telegraphy were made on the line from Euston to Camden Town in 1837, and on the line from Paddington to West Drayton in 1838. The submarine telegraph to America, conceived in 1856, became a practical reality in 1861 through the commercial energy of Cyrus Field and Pender, aided by the mechanical skill of Latimer Clark, Gooch, and others, and the scientific genius of Lord Kelvin. The knowledge of electricity gained by means of its application to the telegraph largely assisted the extension of its utility in other directions. The electric light gives, in its incandescent form, a very perfect hygienic light. Where rivers are at hand the electrical transmission of power will drive railway trains and factories economically, and might enable each artisan to convert his room into a workshop, and thus assist in restoring to the labouring man some of the individuality which the factory has tended to destroy. In 1843 Joule described his experiments for determining the mechanical equivalent of heat. But it was not until the meeting at Oxford, in 1847, that he fully developed the law of the conservation of energy, which, in conjunction with Newton's law of the conservation of momentum, and Dalton's law of the conservation of chemical elements, constitutes a complete mechanical foundation for physical science.

Who, at the foundation of the association, would have believed some far-seeing philosopher if he had foretold that the spectroscope would analyse the constituents of the sun and measure the motions of the stars; that we should liquefy air and utilise temperatures approaching to the absolute zero for experimental research; that, like the magician in the "Arabian Nights," we should annihilate distance by means of the electric telegraph and the telephone; that we should illuminate our largest buildings instantaneously, with the clearness of day, by means of the electric current; that by the electric transmission of power we should be able to utilise the Falls of Niagara to work factories at distant places; that we should extract metals from the crust of the earth by the same electrical agency to which, in some cases, their deposition has been attributed? These discoveries and their applications have been brought to their present condition by the researches of a long line of scientific explorers, such as Dalton, Joule, Maxwell, Helmholtz, Hertz, Kelvin, and Rayleigh, aided by vast strides made in mechanical skill. But what will our successors be discussing 60 years hence? How little do we yet know of the vibrations which communicate light and heat! Far as we have advanced in the application of electricity to the uses of life, we know but little even yet of its real nature. We are only on the threshold of the knowledge of molecular action, or of the constitution of the all-pervading ether. Newton at the end of the seventeenth century, in his preface to the "Principia," says: "I have deduced the motions of the planets by mathematical reasoning from forces, and I would that we could derive the other phenomena of nature from mechanical principles by the same mode of reasoning. For many things move me, so that I somewhat suspect that all such may depend on certain forces by which the particles of bodies through causes not yet known are either urged towards each other according to regular figures, or are repelled and recede from each other, and these forces being unknown philosophers have hitherto made their attempts on Nature in vain. In 1848 Faraday remarked: 'How rapidly the knowledge of molecular forces grows upon us, and how strikingly every investigation tends to develop more and more their importance! A few years ago magnetism was an occult force, affecting only a few bodies; now it is found to influence all bodies, and to possess the most intimate relation with electricity, heat, chemical action, light, crystallisation, and through it the forces concerned in cohesion. We may feel encouraged to continuous labours, hoping to bring it into a bond of union with gravity itself." But it is only within the last few years that we have begun to realise that electricity is closely connected with the vibrations which cause heat and light, and which seem to pervade all space—vibrations which may be termed the voice of the Creator calling to each atom and to each cell of protoplasm to fall into its ordained position, each, as it were, a musical note in the harmonious symphony which we call the universe.

Meteorology.—At the first meeting, in 1831, Prof. James D. Forbes was requested to draw up a report on the state of meteorological science, on the ground that this science is more in want than any other of that systematic direction which it is one great object of the association to give. Prof. Forbes made his first report in 1832, and a subsequent report in 1840. The systematic records now kept in various parts of the world of barometric pressure, of solar heat, of the temperature and physical conditions of the atmosphere at various altitudes, of the heat of the ground at various depths, of the rainfall, of the

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prevalence of winds, and the gradual elucidation not only of the laws which regulate the movements of cyclones and storms, but of the influences which are exercised by the sun and by electricity and magnetism, not only upon atmospheric conditions, but upon health and vitality, are gradually approximating meteorology to the position of an exact science. England took the lead in rainfall observations. Mr. G. J. Symons organised the British rainfall system in 1860 with 178 observers—a system which until 1876 received the help of the British Association. Now Mr. Symons himself conducts it, assisted by more than 3,000 observers, and these volunteers not only make the observations, but defray the expense of their reduction and publication. In foreign countries this work is done by Government officers at the public cost. At the present time a very large number of rain-gauges are in daily use throughout the world. The British Islands have more than 3,000, and India and the United States have nearly as many; France and Germany are not far behind; Australia probably has more—indeed, one colony alone, New South Wales, has more than 1,100. The storm warnings now issued under the excellent systematic organisation of the Meteorological Committee may be said to have had their origin in the terrible storm which broke over the Black Sea during the Crimean War, on November 27, 1855. Leverrier traced the progress of that storm, and seeing how its path could have been reported in advance by the electric telegraph, he proposed to establish observing stations which should report to the coasts the probability of the occurrence of a storm. Leverrier communicated with Airy, and the Government authorised Admiral FitzRoy to make tentative arrangements in this country. The idea was also adopted on the Continent, and now there are few civilised countries north or south of the equator without a system of storm warning.*

Biological Science.

Botany.—The earliest reports of the association which bear on the biological sciences were those relating to botany. In 1831 the controversy was yet unsettled between the advantages of the Linnean, or artificial system, as contrasted with the natural system of classification. Histology, morphology, and physiological botany, even if born, were in their early infancy. Our records show that von Mohl noted cell division in 1835, the presence of chlorophyll corpuscles in 1837, and he first described protoplasm in 1846. Vast as have been the advances of physiological botany since that time, much of its fundamental principles remain to be worked out, and I trust that the establishment, for the first time, of a permanent section for botany at the present meeting will lead the association to take a more prominent part than it has hitherto done in the further development of this branch of biological science.

Animal Physiology.—In 1831 Cuvier, who during the previous generation had, by the collation of facts followed by careful inductive reasoning, established the plan on which each animal is constructed, was approaching the termination of his long and useful life. He died in 1832; but in 1831 Richard Owen was just commencing his anatomical investigations and his brilliant contributions to palæontology. The impulse which their labours gave to biological science was reflected in numerous reports and communications, by Owen and others, throughout the early decades of the British Association, until Darwin propounded a theory of evolution which commanded the general assent of the scientific world. For this theory was not absolutely new. But just as Cuvier had shown that each bone in the fabric of an animal affords a clue to the shape and structure of the animal, so Darwin brought harmony into scattered facts, and led us to perceive that the moulding hand of the Creator may have evolved the complicated structures of the organic world from one or more primeval cells. Richard Owen did not accept Darwin's theory of evolution, and a large section of the public contested it. I well remember the storm it produced—a storm of praise by my geological colleagues, who accepted the result of investigated facts; a storm of indignation such as that which would have burned Galileo at the stake from those who were not yet prepared to question the old authorities; but they diminish daily. We are, however, as yet only on the threshold of the doctrine of evolution. Does not each fresh investigation, even into the embryonic stage of the simpler forms of life, suggest fresh problems?

Anthropology.—The impulse given by Darwin has been fruitful in leading others to consider whether the same principle of evolution may not have governed the moral as well as the material progress of the human race. Mr. Kidd tells us that Nature as interpreted by the struggle for life contains no sanction for the moral progress of the individual, and points out that if each of us were allowed by the conditions of life to follow his own inclination, the average of each generation would distinctly deteriorate from that of the preceding one; but because the law of life is ceaseless and inevitable struggle and competition, ceaseless and inevitable selection and rejection, the result is necessarily ceaseless and inevitable progress. Evolution, as Sir William Flower said, is the message which biology has sent to help us on with some of the problems of human life, and Francis Galton urges that man, the foremost outcome of the awful mystery of evolution, should realise that he has the power of shaping the course of future humanity by using his intelligence to discover and expedite the changes which are necessary to adapt circumstances to man, and man to circumstances. In considering the evolution of the human race, the science of preventive medicine may afford us some indication of the direction in which to seek for social improvement. One of the early steps towards establishing that science upon a secure basis was taken in 1835 by the British Association, who urged upon the Government the necessity of establishing registers of mortality showing the causes of death "on one uniform plan in all parts of the King's dominions, as the only means by which general laws touching the influence of causes of disease and death could be satisfactorily deduced." The general registration of births and deaths was commenced in 1838. But a mere record of death and its proximate cause is insufficient. Preventive medicine requires a knowledge of the details of the previous conditions of life and of occupation. Moreover, death is not our only or most dangerous enemy, and the main object of preventive medicine is to ward off disease. Disease of body lowers our useful energy. Disease of body or of mind may stamp its curse on succeeding generations. The anthropometric laboratory affords to the student of anthropology a means of analysing the causes of weakness, not only in bodily, but also in mental life. Mental actions are indicated by movements and their results. Such signs are capable of record, and modern physiology has shown that bodily movements correspond to action in nerve centres as surely as the motions of the telegraph indicator express the movements of the operator's hands in the distant office. Thus there is a relation between a defective status in brain power and defects in the proportioning of the body. Defects in physiognomical details, too finely graded to be measured with instruments, may be appreciated with accuracy by the senses of the observer, and the records show that these defects are, in a large degree, associated with a brain status lower than the average in mental power. A report presented by one of your committees gives the results of observations made on 100,000 school-children examined individually in order to determine their mental and physical condition for the purpose of classification. This shows that about 16 per 1,000 of the elementary school population appear to be so far defective in their bodily or brain condition as to need special training to enable them to undertake the duties of life, and to keep them from pauperism or crime. Many of our feeble-minded children, and much disease and vice, are the outcome of inherited proclivities. Francis Galton has shown us that types of criminals which have been bred true to their kind are one of the saddest disfigurements of modern civilisation; and he says that few deserve better of their country than those who determine to lead celibate lives through a reasonable conviction that their issue would probably be less fitted than the generality to play their part as citizens. These considerations point to the importance of preventing those suffering from transmissible disease, or the criminal, or the lunatic, from adding fresh sufferers to the teeming misery in our large towns. And in any case, knowing as we do the influence of environment on the development of individuals, they point to the necessity of removing those who are born with feeble minds, or under conditions of moral danger, from surrounding deteriorating influences. These are problems which materially affect the progress of the human race, and we may feel sure that, as we gradually approach their solution, we shall more certainly realise that the theory of evolution, which the genius of Darwin impressed on this century, is but the first step on a biological ladder which may possibly eventually lead us to understand how in the drama of creation man has been evolved as the highest work of the Creator.

Bacteriology.—The sciences of medicine and surgery were largely represented in the earlier meetings of the association before the creation of the British Medical Association afforded a field for their more intimate discussion. The close connection between the different branches of science is causing a revival in our proceedings of discussions on some of the highest medical problems, especially those relating to the spread of infectious and epidemic disease. It is interesting to contrast the opinion prevalent at the foundation of the association with the present position of the question. A report to the association in 1834 by Prof. Henry on contagion says: "The notion that contagious emanations are at all connected with the diffusion of animalculæ through the atmosphere is at variance with all that is known of the diffusion of volatile contagion." Whilst it had long been known that filthy conditions in air, earth, and water fostered fever, cholera, and many other forms of disease, and that the disease ceased to spread on the removal of these conditions, yet the reason for their propagation or

* It has often been supposed that Leverrier was also the first to issue a daily weather map, but that was not the case, for in the Great Exhibition of 1851 the Electric Telegraph Company sold daily weather maps, copies of which are still in existence, and the data for them were, it is believed, obtained by Mr. James Glaisher, F.R.S., at that time superintendent of the Meteorological Department at Greenwich.

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diminution remained under a veil. Leeuwenhoeck in 1680 described the yeast cells, but Schwann in 1837 first showed clearly that fermentation was due to the activity of the yeast cells; and, although vague ideas of fermentation had been current during the past century, he laid the foundation of our exact knowledge of the nature of the action of ferments, both organised and unorganised. It was not until 1860, after the prize of the Academy of Sciences had been awarded to Pasteur for his essay against the theory of spontaneous generation, that his investigations into the action of ferments* enabled him to show that the effects of the yeast cell are indissolubly bound up with the activities of the cell as a living organism, and that certain diseases, at least, are due to the action of ferments in the living being. In 1865 he showed that the disease of silk-worms, which was then undermining the silk industry in France, could be successfully combated. His further researches into anthrax, fowl cholera, swine fever, rabies, and other diseases proved the theory that those diseases are connected in some way with the introduction of a microbe into the body of an animal; that the virulence of the poison can be diminished by cultivating the microbes in an appropriate manner; and that when the virulence has been thus diminished their inoculation will afford a protection against the disease. Meanwhile it had often been observed in hospital practice that a patient with a simple-fractured limb was easily cured, whilst a patient with a compound fracture often died from the wound. Lister was thence led, in 1865, to adopt his antiseptic treatment, by which the wound is protected from hostile microbes. These investigations, followed by the discovery of the existence of a multitude of micro-organisms and the recognition of some of them—such as the bacillus of tubercle and the comma bacillus of cholera—as essential factors of disease; and by the elaboration by Koch and others of methods by which the several organisms might be isolated, cultivated, and their histories studied, have gradually built up the science of bacteriology. Amongst later developments are the discovery of various so-called antitoxins, such as those of diphtheria and tetanus, and the utilisation of these for the cure of disease. Lister's treatment formed a landmark in the science of surgery, and enabled our surgeons to perform operations never before dreamed of, whilst later discoveries are tending to place the practice of medicine on a firm scientific basis; and the science of bacteriology is leading us to recur to stringent rules for the isolation of infectious disease, and to the disinfection (by superheated steam) of materials which have been in contact with the sufferer. These microbes, whether friendly or hostile, are all capable of multiplying at an enormous rate under favourable conditions. They are found in the air, in water, in the soil; but, fortunately, the presence of one species appears to be detrimental to other species, and sunshine, or even light from the sky, is prejudicial to most of them. Our bodies, when in health, appear to be furnished with special means of resisting attacks, and so far as regards their influence in causing disease the success of the attack of a pathogenic organism upon an individual depends, as a rule, in part at least, upon the power of resistance of the individual. But notwithstanding our knowledge of the danger arising from a state of low health in individuals, and of the universal prevalence of these micro-organisms, how careless we are in guarding the health conditions of everyday life! We have ascertained that pathogenic organisms prevade the air. Why, therefore, do we allow our meat, our fish, our vegetables, our easily contaminated milk, to be exposed to their inroads, often in the foulest localities? We have ascertained that they pervade the water we drink, yet we allow foul water from our dwellings, our pigsties, our farmyards, to pass into ditches without previous clarification, whence it flows into our streams and pollutes our rivers. We know the conditions of occupation which foster ill-health. Why, whilst we remove outside sources of impure air, do we permit the occupation of foul and unhealthy dwellings? The study of bacteriology has shown us that although some of these organisms may be the accompaniments of disease, yet we owe it to the operation of others that the refuse caused by the cessation of animal and vegetable life is reconverted into food for fresh generations of plant and animals. These considerations have formed a point of meeting where the biologist, the chemist, the physicist, and the statistician unite with the sanitary engineer in the application of the science of preventive medicine.

Engineering.

Sewage Purification.—The early reports of the association show that the laws of hydrostatics, hydrodynamics, and hydraulics necessary to the supply and removal of water through pipes and conduits had long been investigated by the mathematician. But the modern sanitary engineer has been driven by the needs of an increasing population to call in the chemist and the biologist to help him to provide pure water and pure air. The purification and the utilisation of sewage occupied the attention of the British Association as early as 1864, and between 1869 and 1876 a committee of the association made a series of valuable reports on the subject. The direct application of sewage to land, though effective as a means of purification, entailed difficulties in thickly-settled districts, owing to the extent of land required. The chemical treatment of sewage produced an effluent harmless only after having been passed over land, or if turned into a large and rapid stream, or into a tidal estuary, and it left behind a large amount of sludge to be dealt with. Hence it was long contended that the simplest plan in favourable localities was to turn the sewage into the sea, and that the consequent loss to the land of the manurial value in the sewage would be recouped by the increase in fish life. It was not till the chemist called to his aid the biologist, and came to the help of the engineer, that a scientific system of sewage purification was evolved. Dr. Frankland many years ago suggested the intermittent filtration of sewage, and Mr. Baldwin Latham was one of the first engineers to adopt it. But the valuable experiments made in recent years by the State Board of Health in Massachusetts have more clearly explained to us how by this system we may utilise micro-organisms to convert organic impurity in sewage into food fitted for higher forms of life. To effect this we require, in the first place, a filter about 5ft. thick of sand and gravel, or, indeed, of any material which affords numerous surfaces or open pores. Secondly, that after a volume of sewage has passed through the filter, an interval of time be allowed, in which the air necessary to support the life of the micro-organisms is enabled to enter the pores of the filter. Thus the system is dependent upon oxygen and time. Under such conditions the organisms necessary for purification are sure to establish themselves in the filter before it has been long in use. Temperature is a secondary consideration. Imperfect purification can invariably be traced either to a lack of oxygen in the pores of the filter, or to the sewage passing through so quickly that there is not sufficient time for the necessary processes to take place. And the power of any material to purify either sewage or water depends almost entirely upon its ability to hold a sufficient proportion of either sewage or water in contact with a proper amount of air.

Smoke Abatement.—Whilst the sanitary engineer has done much to improve the surface conditions of our towns, to furnish clean water, and to remove our sewage, he has as yet done little to purify town air. Fog is caused by the floating particles of matter in the air becoming weighted with aqueous vapour; some particles, such as salts of ammonia or chloride of sodium, have a greater affinity for moisture than others. You will suffer from fog so long as you keep refuse stored in your towns to furnish ammonia, or so long as you allow your street surfaces to supply dust, of which much consists of powdered horse manure, or so long as you send the products of combustion into the atmosphere. Therefore, when you have adopted mechanical traction for your vehicles in towns you may largely reduce one cause of fog; and if you diminish your black smoke, you will diminish black fogs. In manufactories you may prevent smoke either by care in firing, by using smokeless coal, or by washing the soot out of the products of consumption in its passage along the flue leading to the main chimney-shaft. The black smoke from your kitchen may be avoided by the use of coke or of gas. But so long as we retain the hygienic arrangement of the open fire in our living-rooms I despair of finding a fireplace, however well constructed, which will not be used in such a manner as to cause smoke, unless, indeed, the chimneys were reversed and the fumes drawn into some central shaft, where they might be washed before being passed into the atmosphere. Electricity as a warming and cooking agent would be convenient, cleanly, and economical when generated by water power, or possibly wind power, but it is at present too dear when it has to be generated by means of coal. I can conceive, however, that our descendants may learn so to utilise electricity that they, in some future century, may be enabled by its means to avoid the smoke in their towns.

Mechanical Engineering. — In other branches of civil and mechanical engineering, the reports in 1831 and 1832 on the state of this science show that the theoretical and practical knowledge of the strength of timber had obtained considerable development. But in 1830, before the introduction of railways, cast iron had been sparingly used in arched bridges for spans of from 160 to 200 feet, and wrought iron had only been applied to large-span iron bridges on the suspension principle, the most notable instance of which was the Menai Suspension Bridge, by Telford. Indeed, whilst the strength of timber had been patiently investigated by engineers, the best form for the use of iron girders and struts was only beginning to attract attention, and the earlier volumes of our *Proceedings* contained numerous records of the researches of Eaton Hodgkinson, Barlow, Rennie, and others. It was not until 20 years later that Robert Stephenson and William Fairbairn erected the tubular bridge at Menai, followed by the more scientific bridge erected by Brunel at Saltash. These have now been entirely

* In speaking of ferments one must bear in mind that there are two classes of ferments: one, living beings, such as yeast—"organised" ferments, as they are sometimes called; the other the products of living beings themselves, such as pepsin, etc.—"unorganised" ferments. Pasteur worked with the former, very little with the latter.

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eclipsed by the skill with which the estuary of the Forth has been bridged with a span of 1,700ft. by Sir John Fowler and Sir Benjamin Baker. The development of the iron industry is due to the association of the chemist with the engineer. The introduction of the hot blast by Neilson, in 1829, in the manufacture of cast iron has effected a large saving of fuel. But the chemical conditions which affect the strength and other qualities of iron, and its combination with carbon, silicon, phosphorus, and other substances, had at that time scarcely been investigated. In 1856 Bessemer brought before the British Association at Cheltenham his brilliant discovery for making steel direct from the blast furnace, by which he dispensed with the laborious process of first removing the carbon from pig iron by puddling and then adding by cementation the required proportion of carbon to make steel. This discovery, followed by Siemens's regenerative furnace, by Whitworth's compressed steel, and by the use of alloys, and by other improvements too numerous to mention here, have revolutionised the conditions under which metals are applied to engineering purposes. Indeed, few questions are of greater interest, or possess more industrial importance, than those connected with metallic alloys. This is especially true of those alloys which contain the rarer metals, and the extraordinary effects of small quantities of chromium, nickel, tungsten, and titanium on certain varieties of steel have exerted profound influence on the manufacture of projectiles and on the construction of our armoured ships.

Of late years, investigations on the properties and structure of alloys have been numerous, and among the more noteworthy researches may be mentioned those of Dewar and Fleming on the distinctive behaviour, as regards the thermo-electric powers and electrical resistance, of metals and alloys at the very low temperatures which may be obtained by the use of liquid air. Prof. Roberts-Austen, on the other hand, has carefully studied the behaviour of alloys at very high temperatures, and by employing his delicate pyrometer has obtained photographic curves which afford additional evidence as to the existence of allotropic modifications of metals, and which have materially strengthened the view that alloys are closely analogous to saline solutions. In this connection it may be stated that the very accurate work of Heycock and Neville on the lowering of the solidifying points of molten metals, which is caused by the presence of other metals, affords a valuable contribution to our knowledge. Prof. Roberts-Austen has, moreover, shown that the effect of any one constituent of an alloy upon the properties of the principal metal has a direct relation to the atomic volumes, and that it is consequently possible to foretell, in a great measure, the effect of any given combination. A new branch of investigation, which deals with the micro-structure of metals and alloys, is rapidly assuming much importance. It was instituted by Sorby in a communication which he made to the British Association in 1864, and its development is due to many patient workers, among whom M. Osmond occupies a prominent place. Metallurgical science has brought aluminium into use by cheapening the process of its extraction ; and if by means of the wasted forces in our rivers, or possibly of the wind, the extraction be still further cheapened by the aid of electricity, we may not only utilise the metal or its alloys in increasing the spans of our bridges, and in affording strength and lightness in the construction of our ships, but we may hope to obtain a material which may render practicable the dreams of Icarus and of Maxim, and for purposes of rapid transit enable us to navigate the air.

Long before 1831 the steam-engine had been largely used on rivers and lakes, and for short sea passages, although the first Atlantic steam service was not established till 1838. As early as 1820 the steam-engine had been applied by Gurney, Hancock, and others to road traction. The absurd impediments placed in their way by road trustees, which, indeed, are still enforced, checked any progress. But the question of mechanical traction on ordinary roads was practically shelved in 1830, at the time of the formation of the British Association, when the locomotive engine was combined with a tubular boiler and an iron road on the Liverpool and Manchester Railway. Great, however, as was the advance made by the locomotive engine of Robert Stephenson, these earlier engines were only toys compared with the compound engines of to-day which are used for railways, for ships, or for the manufacture of electricity. Indeed, it may be said that the study of the laws of heat, which have led to the introduction of various forms of motive power, are gradually revolutionising all our habits of life. The improvements in the production of iron, combined with the developed steam-engine, have completely altered the conditions of our commercial intercourse on land ; whilst the changes caused by the effects of these improvements in shipbuilding, and on the ocean carrying trade, have been, if anything, still more marked. At the foundation of the association all ocean ships were built by hand, of wood, propelled by sails and manœuvred by manual labour ; the material limited their length, which did not often exceed 100ft., and the number of English ships of over 500 tons burden was comparatively small. In the modern ships steam power takes the place of manual labour. It rolls the plates of which the ship is constructed, bends them to the required shape, cuts, drills, and rivets them in their place. It weighs the anchor ; it propelled the ship in spite of winds or currents ; it steers, ventilates, and lights the ship when on the ocean. It takes the cargo on board and discharges it on arrival. The use of iron favours the construction of ships of a large size, of forms which afford small resistance to the water, and with compartments which make the ship practically unsinkable in heavy seas, or by collision. Their size, the economy with which they are propelled, and the certainty of their arrival, cheapens the cost of transport. The steam-engine, by compressing air, gives us control over the temperature of cool-chambers. In these not only fresh meat, but the delicate produce of the Antipodes, is brought across the ocean to our doors without deterioration. Whilst railways have done much to alter the social conditions of each individual nation, the application of iron and steam to our ships is revolutionising the international commercial conditions of the world ; and it is gradually changing the course of our agriculture, as well as of our domestic life.

But great as have been the developments of science in promoting the commerce of the world, science is asserting its supremacy even to a greater extent in every department of war. And perhaps this application of science affords at a glance, better than almost any other, a convenient illustration of the assistance which the chemical, physical, and electrical sciences are affording to the engineers. The reception of warlike stores is not now left to the uncertain judgment of "practical men," but is confided to officers who have received a special training in chemical analysis, and in the application of physical and electrical science to the test by which the qualities of explosives, of guns, and of projectiles can be ascertained. For instance, take explosives. Till quite recently black and brown powders alone were used, the former as old as civilisation, the latter but a small modern improvement adapted to the increased size of guns. But now the whole family of nitro-explosives are rapidly superseding the old powder. These are the direct outcome of chemical knowledge ; they are not mere chance inventions, for every improvement is based on chemical theories, and not on random experiment. The construction of guns is no longer a haphazard operation. In spite of the enormous forces to be controlled and the sudden violence of their action, the researches of the mathematician have enabled the just proportions to be determined with accuracy ; the labours of the physicist have revealed the internal conditions of the materials employed, and the best means of their favourable employment. Take, for example, Longridge's coiled-wire system, in which each successive layer of which the gun is formed receives the exact proportion of tension which enables all the layers to act in unison. The chemist has rendered it clear that even the smallest quantities of certain ingredients are of supreme importance in affecting the tenacity and trustworthiness of the materials. The treatment of steel to adapt it to the vast range of duties it has to perform is thus the outcome of patient research. And the use of the metals—manganese, chromium, nickel, molybdneum—as alloys with iron has resulted in the production of steels possessing varied and extraordinary properties. The steel required to resist the conjugate stresses developed, lightning fashion, in a gun necessitates qualities that would not be suitable in the projectile which that gun hurls with a velocity of some 2,500ft. per second against the armoured side of a ship. The armour, again, has to combine extreme superficial hardness with great toughness, and during the last few years these qualities are sought to be attained by the application of the cementation process for adding carbon to one face of the plate, and hardening that face alone by rapid refrigeration.

The introduction of quick-firing guns from ·303 (*i.e.*, about one-third) of an inch to 6in. calibre has rendered necessary the production of metal cartridge-cases of complex forms drawn cold out of solid blocks or plate of the material ; this, again, has taxed the ingenuity of the mechanic in the device of machinery, and of the metallurgist in producing a metal possessed of the necessary ductility and toughness. The cases have to stand a pressure at the moment of firing of as much as 25 tons to the square inch—a pressure which exceeds the ordinary elastic limits of the steel of which the gun itself is composed. There is nothing more wonderful in practical mechanics than the closing of the breech openings of guns, for not only must they be gas-tight at these tremendous pressures, but the mechanism must be such that one man by a single continuous movement shall be able to open or close the breech of the largest gun in some 10 or 15 seconds. The perfect knowledge of the recoil of guns has enabled the reaction of the discharge to be utilised in compressing air or springs by which guns can be raised from concealed positions in order to deliver their fire, and then made to disappear again for loading; or the same force has been used to run up the guns automatically immediately after firing, or, as in the case of the Maxim gun, to deliver in the same way a continuous stream of bullets at the rate of 10 in one second. In the manufacture of shot and shell cast iron has been almost superseded by cast and wrought steel, though the hardened Palliser projectiles still hold their place. The forged-steel projectiles are produced by methods very similar to those used in the manu-

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facture of metal cartridge-cases, though the process is carried on at a red heat and by machines much more powerful.

In every department concerned in the production of warlike stores electricity is playing a more and more important part. It has enabled the passage of a shot to be followed from its seat in the gun to its destination. In the gun, by means of electrical contacts arranged in the bore, a time curve of the passage of the shot can be determined. From this the mathematician constructs the velocity curve, and from this, again, the pressures producing the velocity are estimated, and used to check the same indications obtained by other means. The velocity of the shot after it has left the gun is easily ascertained by the Boulangé apparatus. Electricity and photography have been laid under contribution for obtaining records of the flight of projectiles and the effects of explosions at the moment of their occurrence. Many of you will recollect Mr. Vernon Boys's marvellous photographs showing the progress of the shot driving before it waves of air in its course. Electricity and photography also record the properties of metals and their alloys as determined by curves of cooling. The readiness with which electrical energy can be converted into heat or light has been taken advantage of for the firing of guns, which in their turn can, by the same agency, be laid on the object by means of range-finders placed at a distance and in advantageous and safe positions; while the electric light is utilised to illumine the sights at night as well as to search out the objects of attack. The compact nature of the incandescent lamp, the brightness of the light, the circumstance that the light is not due to combustion and therefore independent of air, facilitates the examination of the bore of guns, the insides of shells, and other similar uses—just as it is used by a doctor to examine the throat of a patient.

Influence of Intercommunication afforded by British Association on Science Progress.

The advances in engineering which have produced the steam-engine, the railway, the telegraph, as well as our engines of war, may be said to be the result of commercial enterprise rendered possible only by the advances which have taken place in the several branches of science since 1831. Having regard to the intimate relations which the several sciences bear to each other, it is abundantly clear that much of this progress could not have taken place in the past, nor could further progress take place in the future, without intercommunication between the students of different branches of science. The founders of the British Association based its claims to utility upon the power it afforded for this intercommunication. Mr. Vernon-Harcourt (the uncle of your present general secretary), in the address he delivered in 1832, said: "How feeble is man for any purpose when he stands alone—how strong when united with other men! It may be true that the greatest philosophical works have been achieved in privacy, but it is no less true that these works would never have been accomplished had the authors not mingled with men of corresponding pursuits, and from the commerce of ideas often gathered germs of apparently insulated discoveries, and without such material aid would seldom have carried their investigations to a valuable conclusion." I claim for the British Association that it has fulfilled the object of its founders, that it has had a large share in promoting intercommunication and combination. Our meetings have been successful because they have maintained the true principles of scientific investigation. We have been able to secure the continued presence and concurrence of the master-spirits of science. They have been willing to sacrifice their leisure, and to promote the welfare of the association, because the meetings have afforded them the means of advancing the sciences to which they are attached. The association has, moreover, justified the views of its founders in promoting intercourse between the pursuers of science, both at home and abroad, in a manner which is afforded by no other agency. The weekly and sessional reunions of the Royal Society and the annual soirées of other scientific societies promote this intercourse to some extent, but the British Association presents to the young student during its week of meetings easy and continuous social opportunities for making the acquaintance of leaders in science, and thereby obtaining their directing influence. It thus encourages, in the first place, opportunities of combination, but, what is equally important, it gives at the same time material assistance to the investigators whom it thus brings together. The reports on the state of science at the present time, as they appear in the last volume of our *Proceedings*, occupy the same important position, as records of science progress, as that occupied by those reports in our earlier years. We exhibit no symptom of decay.

Science in Germany fostered by the State and Municipalities.

Our neighbours and rivals rely largely upon the guidance of the State for the promotion of both science teaching and of research. In Germany the foundations of technical and industrial training are laid in the Realschulen, and supplemented by the higher technical schools. In Berlin that splendid institution, the Royal Technical High School, casts into the shade the facilities for education in the various polytechnics which we are now establishing in London. Moreover, it assists the practical workman by a branch department, which is available to the public for testing building materials, metals, paper, oil, and other matters. The standards of all weights and measures used in trade can be purchased from or tested by the Government Department for Weights and Measures. For developing pure scientific research and for promoting new applications of science to industrial purposes the German Government, at the instance of von Helmholtz, and aided by the munificence of Werner von Siemens, created the Physikalische Technische Reichsanstalt at Charlottenburg. This establishment consists of two divisions. The first is charged with pure research, and is at the present time engaged in various thermal, optical, and electrical and other physical investigations. The second branch is employed in operations of delicate standardising to assist the wants of research students—for instance, dilatation, electrical resistances, electric and other forms of light, pressure gauges, recording instruments, thermometers, pyrometers, tuning-forks, glass, oil-testing apparatus, viscosity of glycerine, etc. Dr. Kohlrausch succeeded Helmholtz as president, and takes charge of the first division. Prof. Hagen, the director under him, has charge of the second division. A professor is in charge of each of the several sub-departments. Under these are various subordinate posts, held by younger men, selected for previous valuable work, and usually for a limited time. The general supervision is under a council, consisting of a president, who is a privy councillor, and 24 members, including the president and director of the Reichsanstalt; of the other members, about 10 are professors or heads of physical and astronomical observatories connected with the principal universities in Germany. Three are selected from leading firms in Germany representing mechanical, optical, and electric science, and the remainder are principal scientific officials connected with the Departments of War and Marine, the Royal Observatory at Potsdam, and the Royal Commission for Weights and Measures. This council meets in the winter, for such time as may be necessary, for examining the research work done in the first division during the previous year, and for laying down the scheme for research for the ensuing year; as well as for suggesting any requisite improvements in the second division. As a consequence of the position which science occupies in connection with the State in Continental countries, the services of those who have distinguished themselves either in the advancement or in the application of science are recognised by the award of honours; and thus the feeling for science is encouraged throughout the nation.

Assistance to Scientific Research in Great Britain.

Great Britain maintained for a long time a leading position among the nations of the world by virtue of the excellence and accuracy of its workmanship, the result of individual energy; but the progress of mechanical science has made accuracy of workmanship the common property of all nations of the world. Our record shows that hitherto, in its efforts to maintain its position by the application of science and the prosecution of research, England has made marvellous advances by means of voluntary effort, illustrated by the splendid munificence of such men as Gassiot, Joseph Whitworth, James Mason, and Ludwig Mond; and, whilst the increasing field of scientific research compels us occasionally to seek for Government assistance, it would be unfortunate if by any change voluntary effort were fettered by State control.

The following are the principal voluntary agencies which help forward scientific research in this country: the Donation Fund of the Royal Society, derived from its surplus income. The British Association has contributed £60,000 to aid research since its formation. The Royal Institution, founded in the last century, by Count Rumford, for the promotion of research, has assisted the investigations of Davy, of Young, of Faraday, of Frankland, of Tyndall, of Dewar, and of Rayleigh. The City companies assist scientific research and foster scientific education both by direct contributions and through the City and Guilds Institute. The Commissioners of the Exhibition of 1851 devote £6,000 annually to science research scholarships, to enable students who have passed through a college curriculum and have given evidence of capacity for original research to continue the prosecution of science, with a view to its advance or to its application to the industries of the country. Several scientific societies, as, for instance, the Geographical Society and the Mechanical Engineers, have promoted direct research, each in their own branch of science, out of their surplus income; and every scientific society largely assist research by the publication, not only of its own proceedings, but often of the work going on abroad in the branch of science which it represents. The growing abundance of matter year by year increase the burden thus thrown on their finances, and the Treasury has recently granted to the Royal Society £1,000 a year, to be spent in aid of the publication of scientific papers not necessarily limited to those of that society. The Royal Society has long felt the importance to scientific research of a catalogue of all papers and publications relating to pure and applied science, arranged systematically both as to authors' names and as to

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subject treated, and the society has been engaged for some time upon a catalogue of that nature. But the daily increasing magnitude of these publications, coupled with the necessity of issuing the catalogue with adequate promptitude, and at appropriate intervals, renders it a task which could only be performed under international co-operation. The officers of the Royal Society have therefore appealed to the Government to urge foreign Governments to send delegates to a conference to be held next July to discuss the desirability and the scope of such a catalogue, and the possibility of preparing it.

The universities and colleges distributed over the country, besides their function of teaching, are large promoters of research, and their voluntary exertions are aided in some cases by contributions from Parliament in alleviation of their expenses. Certain executive departments of the Government carry on research for their own purposes, which in that respect may be classed as voluntary. The Admiralty maintains the Greenwich Observatory, the Hydrographical Department, and various experimental services; and the War Office maintains its numerous scientific departments. The Treasury maintains a valuable chemical laboratory for Inland Revenue, Customs, and agricultural purposes. The Science and Art Department maintains the Royal College of Science, for the education of teachers and students from elementary schools. It allows the scientific apparatus in the national museum to be used for research purposes by the professors. The Solar Physics Committee, which has carried on numerous researches in solar physics, was appointed by and is responsible to this department. The department also administers the Sir Joseph Whitworth engineering research scholarships. Other scientific departments of the Government are aids to research, as, for instance, the Ordnance and the Geological Surveys, the Royal Mint, the Natural History Museum, Kew Gardens, and other lesser establishments in Scotland and Ireland; to which may be added, to some extent, the Standards Department of the Board of Trade, as well as municipal museums, which are gradually spreading over the country. For direct assistance to voluntary efforts the Treasury contributes £4,000 a year to the Royal Society for the promotion of research, which is administered under a Board whose members represent all branches of science. The Treasury, moreover, contributes to marine biological observatories, and in recent years has defrayed the cost of various expeditions for biological and astronomical research, which in the case of the "Challenger" expedition involved very large sums of money.

In addition to these direct aids to science, Parliament, under the Local Taxation Act, handed over to the county councils a sum, which amounted in the year 1893 to £615,000, to be expended on technical education. In many country districts, so far as the advancement of real scientific technical progress in the nation is concerned, much of this money has been wasted for want of knowledge. And whilst it cannot be said that the Government or Parliament have been indifferent to the promotion of scientific education and research, it is a source of regret that the Government did not devote some small portion of this magnificent gift to affording an object-lesson to county councils in the application of science to technical instruction, which would have suggested the principles which would most usefully guide them in the expenditure of this public money. Government assistance to science has been based mainly on the principle of helping voluntary effort. The Kew Observatory was initiated as a scientific observatory by the British Association. It is now supported by the Gassiot trust fund, and managed by the Kew Observatory Committee of the Royal Society. Observations on magnetism, on meteorology, and the record of sun-spots, as well as experiments upon new instruments for assisting meteorological, thermometrical, and photographic purposes, are being carried on there. The committee has also arranged for the verification of scientific measuring instruments, the rating of chronometers, the testing of lenses and of other scientific apparatus. This institution carries on to a limited extent some small portion of the class of work done in Germany by that magnificent institution, the Reichsanstalt at Charlottenburg, but its development is fettered by want of funds. British students of science are compelled to resort to Berlin and Paris when they require to compare their more delicate instruments and apparatus with recognised standards. There could scarcely be a more advantageous addition to the assistance which Government now gives to science than for it to allot a substantial annual sum to the extension of the Kew Observatory, in order to develop it on the model of the Reichsanstalt. It might advantageously retain its connection with the Royal Society, under the committee of management representative of the various branches of science concerned, and of all parts of Great Britain.

Conclusion.

The various agencies for scientific education have produced numerous students admirably qualified to pursue research; and at the same time almost every field of industry presents openings for improvement through the development of scientific methods. For instance, agricultural operations alone offer openings for research to the biologist, the chemist, the physicist, the geologist, the engineer, which have hitherto been largely overlooked. If students do not easily find employment, it is chiefly attributable to a want of appreciation for science in the nation at large. This want of appreciation appears to arise from the fact that those who nearly half a century ago directed the movement of national education were trained in early life in the universities, in which the value of scientific methods was not at that time fully recognised. Hence our elementary, and even our secondary and great public schools, neglected for a long time to encourage the spirit of investigation which develops originality. This defect is diminishing daily.

There is, however, a more intangible cause which may have had influence on the want of appreciation of science by the nation. The Government, which largely profits by science, aids it with money, but it has done very little to develop the national appreciation for science by recognising that its leaders are worthy of honours conferred by the State. Science is not fashionable, and science students—upon whose efforts our progress as a nation so largely depends—have not received the same measure of recognition which the State awards to services rendered by its own officials, by politicians, and by the army and by the navy, whose success in future wars will largely depend on the effective applications of science.

The reports of the British Association afford a complete chronicle of the gradual growth of scientific knowledge since 1831. They show that the association has fulfilled the objects of its founders in promoting and disseminating a knowledge of science throughout the nation. The growing connection between the sciences places our annual meeting in the position of an arena where representatives of the different sciences have the opportunity of criticising new discoveries and testing the value of fresh proposals, and the presidential and sectional addresses operate as an annual stock-taking of progress in the several branches of science represented in the sections. Every year the field of usefulness of the association is widening. For, whether with the geologist we seek to write the history of the crust of the earth, or with the biologist to trace out the evolution of its inhabitants, or whether with the astronomer, the chemist, and the physicist we endeavour to unravel the constitution of the sun and the planets or the genesis of the nebulæ and stars which make up the universe, on every side we find ourselves surrounded by mysteries which await solution. We are only at the beginning of work.

I have, therefore, full confidence that the future records of the British Association will chronicle a still greater progress than that already achieved, and that the British nation will maintain its leading position amongst the nations of the world, if it will energetically continue its voluntary efforts to promote research, supplemented by that additional help from the Government which ought never to be withheld when a clear case of scientific utility has been established.

ADDRESS TO THE MATHEMATICAL AND PHYSICAL SECTION OF THE BRITISH ASSOCIATION.

BY PROF. W. M. HICKS, M A, D SC., F.R S., PRESIDENT OF THE SECTION.

In making a choice of subject for my address, the difficulty is not one of finding material but of making selection. The field covered by this section is a wide one. Investigation is active in every part of it, and is being rewarded with a continuous stream of new discoveries and with the growth of that co-ordination and correlation of facts which is the surest sign of real advancement in science. The ultimate aim of pure science is to be able to explain the most complicated phenomena of Nature as flowing by the fewest possible laws from the simplest fundamental data. A statement of a law is either a confession of ignorance or a mnemonic convenience. It is the latter if it is deducible by logical reasoning from other laws. It is the former when it is only discovered as a fact to be a law. While, on the one hand, the end of scientific investigation is the discovery of laws; on the other, science will have reached its highest goal when it shall have reduced ultimate laws to one or two, the necessity of which lies outside the sphere of our cognition. These ultimate laws—in the domain of physical science at least—will be the dynamical laws of the relations of matter to number, space, and time. The ultimate data will be number, matter, space, and time themselves. When these relations shall be known, all physical phenomena will be a branch of pure mathematics. We shall have done away with the necessity of the conception of potential energy, even if it may still be convenient to retain it; and—if it should be found that all phenomena are manifestations of motion of one single continuous medium—the idea of force will be banished also, and the study of dynamics replaced by the study of the equation of continuity.

Before, however, this can be attained, we must have the working drawings of the details of the mechanism we have to deal with. These details lie outside the scope of our bodily senses; we cannot see, or feel, or hear them, and this, not because they are unseeable, but because our senses are too coarse-grained to transmit impressions of them to our mind. The ordinary methods of investi-

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gation here fails us; we must proceed by a special method, and make a bridge of communication between the mechanism and our senses by means of hypotheses. By our imagination, experience, intuition, we form theories; we deduce the consequences of these theories on phenomena which come within the range of our senses, and reject or modify and try again. It is a slow and laborious process. The wreckage of rejected theories is appalling; but a knowledge of what actually goes on behind what we can see or feel is surely, if slowly, being attained. It is the rejected theories which have been the necessary steps towards formulating others nearer the truth. It would be an extremely interesting study to consider the history of these discarded theories; to show the part they have taken in the evolution of truer conceptions, and to trace the persistence and modification of typical ideas from one stratum of theories to a later. I propose, however, to ask your attention for a short time to one of these special theories—or, rather, to two related theories—on the constitution of matter and of the ether. They are known as the vortex atom theory of matter, and the vortex sponge theory of the ether. The former has been before the scientific world for a quarter of a century—since its first suggestion by Lord Kelvin in 1867; the second for about half that time. In what I have to say I wish to take the position, not of an advocate for or against, but simply as a prospector attempting to estimate what return is likely to be obtained by laying down plant to develop an unknown district. This is, in fact, the state of these two theories at present. Extremely little progress has been made in their mathematical development, and until this has been done more completely we cannot test them as to their powers of adequately explaining physical phenomena.

The theory of the rigid atom has been a very fruitful one, especially in explaining the properties of matter in the gaseous state; but it gives no explanation of the apparent forces which hold atoms together, and in many other respects it requires supplementing. The elastic solid ether explains much, but there are difficulties connected with it—especially in connection with reflection and refraction—which decide against it. The mathematical rotational ether of MacCullagh is admirably adapted to meet these difficulties, but he could give no physical conception of its mechanism. Maxwell and Faraday proposed a special ether for electrical and magnetic actions. Maxwell's identification of the latter with the luminiferous ether, his deduction of the velocity of propagation of light and of indices of refraction in terms of known electrical and magnetic constants, will form one of the landmarks in the history of science. This ether requires the same mathematical treatment as that of MacCullagh. Lord Kelvin's gyrostatic model of an ether is also of the MacCullagh type. Lastly, we have Lord Kelvin's labile ether, which again avoids the objections to the elastic solid ether. In MacCullagh's type of ether the energy of the medium when disturbed depends only on the twists produced in it. This ether has recently been mathematically discussed by Dr. Larmor, who has shown that it is adequate to explain all the various phenomena of light, electricity, and magnetism. To this I hope to return later. Meanwhile, it may be borne in mind that the vortex sponge ether belongs to MacCullagh's type.

Already, before a formal theory of a fluid ether had been attempted, Lord Kelvin had proposed his theory of vortex atoms. The permanence of a vortex filament with its infinite flexibility, its fundamental simplicity with its potential capacity for complexity, struck the scientific imagination as the thing which was wanted. Unfortunately, the mathematical difficulties connected with the discussion of these motions, especially the reactions of one on another, have retarded the full development of the theory. Two objections in chief have been raised against it—viz., the difficulty of accounting for the densities of various kinds of matter—and the fact that in a vortex ring the velocity of translation decreases as the energy increases. There are two ways of dealing with a difficulty occurring in a general theory—one is to give up the theory, the other is to try and see if it can be modified to get over the difficulty. Such difficulties are to be welcomed as means of help in arriving at greater exactness in details. It is a mistake to submit too readily to crucial experiments. The very valid crucial objection of Stokes to MacCullagh's ether is a case in point. It drew away attention from a theory which, in the light of later developments, gives great hope of leading us to correct ideas. As Larmor has pointed out, this objection vanishes when we have intrinsic rotations in the ether itself. A special danger to guard against is the importation into one theory of ideas which have grown out of one essentially different. This remark has reference to the apparent difficulty of decrease of velocity with increased energy.

Maxwell was, I believe, the first to point out the difficulty of explaining the masses of the elements on the vortex atom hypothesis. To me it has always appeared one of the greatest stumbling-blocks to the acceptance of the theory. We have always been accustomed to regard the ether as of extreme tenuity, as of a density extremely though not infinitely smaller than that of gross matter, and we carry in our minds that Lord Kelvin has given an inferior limit of about 10^{-19}. There are two directions in which to seek a solution. The first is to cut the knot by supposing that the atoms of gross matter are composed of filaments whose rotating cores are of much greater density than the ether itself. The second is to remember that Lord Kelvin's number was obtained on the supposition of elastic solid ether, and does not necessarily apply to the vortex sponge. Unfortunately, however, for the first explanation, the mathematical discussion* shows that a ring cannot be stable unless the density of the fluid outside the core is equal to, or greater than, that inside. This instability also cannot be cured by supposing an additional circulation added outside the core. Unless, therefore, some modification of the theory can be made to secure stability, this idea of dense fluid cores must be given up.

We seem, therefore, forced back to the conclusion that the density of the ether must be comparable with that of ordinary matter. The effective mass of any atom is not composed of that of its core alone, but also of that portion of the surrounding ether which is carried along with it as it moves through the medium. Thus a rigid sphere moving in a liquid behaves as if its mass were increased by half that of the displaced liquid. In the case of a vortex filament the ratio of effective to actual mass may be much larger. In this explanation the density of the matter composing an atom is the same for all, whilst their masses depend on their volumes and configurations combined. Now, the configuration alters with the energy, and this would make the mass depend to some extent at least on the temperature. However repugnant this may be to current ideas, we are not entitled to deny its possibility, although such an effect must be small or it would have been detected. Such a variation, if it exists, is not to be looked for by means of the ordinary gravitation balance, but by the inertia or ballistic balance. The mass of the core itself remains, of course, constant, but the effective mass—that which we can measure by the mechanical effects which the moving vortex produces—is a much more complicated matter, and requires much fuller consideration than has been given to it.

The conditions of stability allow us to assume vacuous cores or cores of less density than the rest of the medium. If we do this, then the density of the ether itself may be greater than that of gross matter. Until, however, we meet with phenomena whose explanation requires this assumption, it would seem preferable to take the density everywhere the same. In this case the density of the ether must be rather less than the apparent density of the lightest of any of the elements, taking the apparent density to mean the effective mass of a vortex atom per its volume. This will probably be commensurable with the density of the matter in its most compressed state, and will lie between ·5 and 1—comparable, that is to say, with the density of water. Larmor, from a special form of hypothesis for a magnetic field in the rotationally elastic ether, is led to assign a density of the same order of magnitude. If the density be given it is easy to calculate the intrinsic energy per cubic centimetre in the medium. The velocity of propagation of light in a vortex sponge ether, as deduced by Lord Kelvin, is ·47 time the mean square velocity of the intrinsic motion of the medium. This gives for the mean square velocity $6{\cdot}3 \times 10^{10}$cm. per second. If we follow Lord Kelvin and use for comparison the energy of radiation per cubic centimetre near the sun, or, say, 1·8 erg per cubic centimetre, the resulting density will be 10^{-21}. The energy per cubic centimetre in a magnetic field of 15,000 C.G.S. units is about one joule. If we take this for comparison we get a density of 10^{-14}. But the intrinsic energy of the fluid must be extremely great compared with the energy it has to transmit. If it were a million times greater the density would still only amount to 10^{-8}—comparable with the density of the residual gas in our highest vacua. To account for the density of gross matter on the supposition that it is built up out of the same material as the ether leads to a density between ·5 and 1. This gives the enormous energy of 10^{14} joules per cubic centimetre. In other words, the energy contained in one cubic centimetre of the ether is sufficient to raise a kilometre cube of lead one metre high against its weight. Thus the difficulty in explaining the mass of ordinary matter seems to reduce itself to a difficulty in believing that the ether possesses such an enormous store of energy. It may be that there are special reasons against such a large density. Larmor refers to the large forcives which would be called into play by hydrodynamical motions. Perhaps an answer to this may be found in the remark that where all the matter is of the same density the motions are kinematically deducible from the configuration at the instant, and are independent of the density. It is only where other causes act, such, *e.g.*, as indirectly depend on the mean pressure of the fluid or where vacuous spaces occur, that the actual value of the density may modify the measurable forcives.

Ever since Prof. J. J. Thomson proved that a vortex atom theory of matter is competent to serve as a basis of a kinetic theory of gases it has been urged by various persons as a fatal objection that the translation velocity of the atoms falls off as the temperature rises. I must confess this objection has never appealed to me. Why should not the velocity fall off? The velocity of gaseous molecules has never been directly observed, nor has it been experimentally proved that it increases with rise of temperature. We have no right to import ideas based on the kinetic theory of hard discrete atoms into the totally distinct theory of mobile atoms in continuity with the medium surrounding them. Doubtless the molecules of a gas effuse through a small orifice more quickly as the temperature rises, but it is natural to suppose that a vortex ring would do the same as its energy increases. To make the objection valid, it is necessary to show that a vortex ring passing through a small tube, comparable with its own diameter, would pass through more slowly the greater its energy. It is not, however, necessarily the case that in every vortex aggregate the velocity decreases as the energy increases. The mathematical treatment of thin vortex filaments is comparatively easy, and little attention has been paid to other cases. Let us attempt to trace the life history as to translation velocity and energy

* An error in the expression on page 768 of "Researches in the Theory of Vortex Rings," *Phil. Trans.*, part ii., 1885, vitiates the conclusion there drawn. If this be corrected the result mentioned above follows. See also Basset, *Treatise on Hydro-dynamics*, § 338, and *Amer. Jour. Math.*

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of a vortex ring. We start with the energy large; the ring now has a very large aperture, and has a very thin filament. As the energy decreases the aperture becomes smaller, the filament thicker, and the velocity of translation greater. We can trace quantitatively the whole of this part of its history until the thickness of the ring has increased to about four times the diameter of the aperture, or perhaps a little further. Then the mathematical treatment employed fails us or becomes very laborious to apply. Till 18 months ago this was the only portion of its history we could trace. Then Prof. J. M. Hill published his beautiful discovery of the existence of a spherical vortex. This consists of a spherical mass of fluid in vortical motion and moving bodily through the surrounding fluid, precisely as if it were a rigid sphere. This enables us to catch a momentary glimpse, as it were, of our vortex ring some little time after it has passed out of our ken. The aperture has gone on contracting, the ring thickening, and altering the shape of its cross-section in a manner whose exact details have not yet been calculated. At last we just catch sight of it again as the aperture closes up. We find the ring has changed into a spherical ball, with still further diminished energy and increased velocity. We then lose sight of it again, but it now lengthens out, and towards the end of its course approximates to the form of a rod moving parallel to its length through the fluid with energy and velocity which again can be approximately determined. In this part of its life the velocity of translation decreases with decrease of energy. I believe it will be found, when the theory is completely worked out, that the spherical atom is the stage where this reversal of property takes place.

Even in the ring state, however, the change of velocity with energy is very small; much smaller, I think, than is generally recognised. When the energy is increased to 20 times that of the spherical vortex, the velocity is only diminished to two-thirds its previous value. If at ordinary temperatures, say 27deg. C., the vortex was in the spherical shape, then at 3,000deg. C. its velocity of translation would only have been reduced to four-fifths its value at the lower temperature, whilst the aperture of the ring would have a radius about 1·4 time that of the sphere. At 2,000deg. C. the velocity would not differ by much more than one-twentieth from its original value. In fact, near the spherical state the alteration in velocity of translation is very slow. It is therefore possible, that if the atoms of matter be vortex aggregates, the state in which we can experimentally test our theory is just that in which the mathematical discussion fails us. Other modifications tend to diminish this change of velocity. I will refer here to three only. The first is that of hollow vortices. We must not, however, postulate vacuous atoms without any rotational core at all; for in this case we should probably lose the essential property of permanence. The question has not been fully investigated, but there can be little doubt but that by diminishing the energy of a completely hollow vortex we can cause it to disappear. We can certainly create one in a perfect fluid. Secondly, J. J. Thomson has shown that if a molecule be composed of linked filaments, the energy increases as the components move further apart. In such a case an extra supply of energy goes to expanding the molecule, and less, if any, to increasing the aperture. Lastly, a modification of the atomic motion, to which I shall refer later, and which seems called for to explain the magnetic rotation of the plane of polarisation of light, will also tend to lessen the change of size, and therefore change of velocity with change of energy, even if it does not reverse the property.

If we pass on to consider how a vortex atom theory lends itself to the explanation of physical and chemical properties of matter independently of what may be called ether-relations, we find that we owe almost all our knowledge on this point to the work of Prof. J. J. Thomson, which obtained the Adams prize in 1882. This, however, is confined to the treatment of thin vortex rings, still leaving a wide field for future investigation in connection with thick rings and with vortex aggregates which produce no cyclosis in the surrounding medium. His work is an extremely suggestive one. He shows that such a theory is capable not only of explaining the gaseous laws of a so-called perfect gas, but possibly also the slight deviations therefrom. Quite as striking is his explanation of chemical combination—an explanation which flows quite naturally from the theory. A vortex filament can be linked on itself; two or more can be linked together, like helices drawn on an anchor-ring; or, lastly, several can be arranged together like parallel rings successively threading one another. In the latter case, for such an arrangement to be permanent, the strengths of each ring must be the same, and, further, not more than six can thus be combined together. The linked vortices will be in permanent combination on account of their linkedness; the other arrangement may be permanent if subject to no external actions. If, however, they are disturbed by the presence of other vortices they may break up. When atoms are thus combined to form a compound, a certain number of molecules will always be dissociated. The compound will be permanent when the ratio of the average paired time to the unpaired time of any atom is large. Thomson considers every filament to be of the same strength. Then an atom consisting of two links will behave like a ring of twice the strength, one of three links, of three times the strength, and so on. On this theory chemical compounds are to be regarded as systems of rings, not linked into one another but close together, and all engaged in the operation of threading each other. The conditions for permanence are: (1) the strength of each ring must be the same, (2) the number must be less than six. Now apply this. H and Cl have equal linkings, therefore equal strength. Consequently, we can have molecules of HCl, or any combinations up to six atoms per molecule, although the simpler one is most likely. O has twice the linking, therefore the strength double. Hence one of H and one of O cannot revolve in permanent connection. We require first to arrange two of H together to form one system. This system has the same strength as O, and can therefore revolve in permanent connection, and we get the water molecule. Or we may take two of the O atoms and one of the double H molecule, and they can form a triple system of three rings threading one another in permanent connection, and we get the molecule H_2O_2. This short example will be sufficient to indicate how the theory gives a complete account of valency.

The energy of rings thus combined is less than when free; consequently they are stable, and the act of combination sets free energy. Further, Thomson points out that for two rings to combine their sizes must be about the same when they come into proximity; consequently, combination can only occur between two limits of temperature corresponding to the energies within which the radii of both kinds of rings are near an equality. We can easily extend Thomson's reasoning to explain the combination of two elements by the presence of a third neutral substance. Call the two elements which are to combine A and B, and the neutral substance C. The radii of A and B are to be supposed too unequal to allow them to come close enough together to combine. If, now, at the given temperature the C atom has a radius intermediate to those of A and B, it is more nearly equal to each than they are to one another; C picks up one of A, and after a short time drops it; A will leave C with its radius brought up, say, to closer equality with it. The same thing happens with the B atoms, and they leave C with their radii brought down to closer equality with it. The result is that A and B are brought into closer equality with one another, and if this is of sufficient amount they can combine, and do so, while C remains as before and apparently inert. Thomson's theory of chemical combination applies only to thin rings. Something analogous may hold also for thick rings, but it is clearly inapplicable to vortex aggregates similar to that of Hill's. We are not confined, however, to this particular kind of association of vortex atoms in a molecule. For instance, I have recently found that one of Hill's vortices can swallow up another and retain it inside in relative equilibrium. The matter requires fuller discussion, but it seems to open up another mode of chemical combination.

A most important matter which has not yet been discussed at all is the relation between the mean energy of the vortex cores, and the energy of the medium itself when the atoms are close enough to affect each other's motions (as in a gas). The fundamental ideas are quite different from those underlying the well-known kinetic theory of gases of hard atoms. Nevertheless, many of the results must be very similar, based as both are on dynamical ideas. Whether it will avoid certain difficulties of the latter, especially those connected with the ratio of the specific heats, remain to be seen. The first desideratum is the determination of the equilibrium of energy between vortices and medium, and before this is done it is useless to speculate further in this region.

A vortex atom theory of matter carries with it the necessity of a fluid ether. If such a fluid is to transmit transversal radiations, some kind of quasi elasticity must be produced in it. This can be done by supposing it to possess energetic rotational motions whose mean velocity is zero, within a volume whose linear dimension is small compared with the wave-length of light, but whose velocity of mean square is considerable. That an ether thus constituted is capable of transmitting transverse vibrations I showed before this section at the Aberdeen meeting of the association by considering a medium composed of closely-packed discrete small vortex rings. Lord Kelvin at the Manchester meeting discussed the question much more thoroughly and satisfactorily, and deduced that the velocity of propagation was $\sqrt{2/3}$ times the velocity of mean square of the turbulent motion. We can make little further progress until we know something of the arrangement of the small motions which confer the quasi-rigidity. This may be completely irregular and unsteady, or arranged in some definite order of steady motions. I am inclined to the view that the latter is nearer the truth. In this case we should expect a regular structure of small cells in which the motions are all similar. By the word cell I do not mean a small vessel bounded by walls, but a portion of the fluid in which the motion is a complete system in itself. Such a theory might be called a cell theory of the ether. The simplest type, perhaps, is to suppose the medium spaced into rectangular boxes, in each of which the motion may be specified as follows. Holding the box with one set of faces horizontal the fluid streams up in the centre of the box, then turns round, flows down the sides and up the centre again. In fact, it behaves like a Hill's vortex squeezed from a spherical into a box form. Each box has thus rotational circulation complete in itself. The six adjoining compartments have their motion the same in kind but in the reverse direction, and so on. In this way we get continuous and energetic small motions throughout the medium, and the state is a stable one. If there is a shear, so that each cell becomes slightly rhomboidal, the rotational motions inside tend to prevent it, and thus propagate the disturbance, but the cells produce no effect on the general irrotational motion of the fluid, at least when the irrotational velocities are small compared with those of the propagation of light. In this case the rate at which the cells adjust themselves to an equilibrium position is far quicker than the rate at which this equilibrium distribution is disturbed by the gross motions. The linear dimensions of the cells must be small compared with the wave lengths of light. They must probably be small also compared with the atoms of gross matter, which are themselves small compared with the same standard.

We may regard each cell as a dynamical system by itself, into which we pour or take away energy. This added energy will depend only on the shape into which the box is de-formed. We may then, for our convenience in considering the gross motions of

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the medium as a whole—*i.e.*, our secondary medium—regard these as interlocked systems, neglect the direct consideration of the motions inside them, but regard the energy which they absorb as a potential function for the general motion. This potential function will contain terms of two kinds, one involving the shear of the cells, and this shear will be the same as the rotational deformation in the secondary medium. The second will depend on alterations in the ratios of the edges of the cells, including other changes of form involving no rotations. The former will give rise to waves of transversal displacements. The second cannot be transmitted as waves, but may produce local effects.

If a continuous solid be placed in such a medium, the cells will rearrange themselves so as to keep the continuity of their motions. The cells will become distorted (but without resultant shear), and a static stress will be set up. We have then to deal with the primary stuff itself whose rotation gives a structure to the ether, and the structural ether itself. The former we may call the primary medium. The ether which can transmit transversal disturbances, and which is built up out of the first, we may call the secondary medium. Whether an atom of matter is to be considered as a vortical mass of the primary or of the secondary medium is a matter to be left open in the present state of the theory.

At the Bath meeting of this association I sketched out a theory of the electrical action of a fluid ether in which electrical lines of force were vortex filaments combined with an equivalent number of hollow vortices of the same vortical strength. An electric charge on a body depended on the number of ends of filaments abutting on it, the sign being determined by the direction of rotation of the filament looked at from the body. This theory gave a complete account of electrostatic actions, both quantitatively and qualitatively, and a more speculative one as to currents and magnetism. I could only succeed in proving at that time that if the filaments were distributed according to the same laws as electric lines of force, the distribution would be one of equilibrium. Larmor has recently proved that this is also the necessary distribution for any type of a rotationally elastic ether, and consequently also for this particular case. Currents along a wire were supposed to consist of the ends of filaments running along it, with disappearance of the hollow companions, the filaments producing at the same time a circulation round the wire. A magnetic field was thus to be produced by a flow of the ether, but probably with the necessary accompaniment of rotational elements in it. This latter, however, was clearly wrong, because each kind of filament would produce a circulation in opposite directions. The correct deduction would have been to lay stress on the fact that the field is due to the motion through the stationary ether of the vortex filaments, the field being perpendicular to the filament and to its direction of motion. This motion would doubtless produce stresses in the cell-ether due to deformations of the cells, and be the proximate cause of the mechanical forces in the field. In any case, it is not difficult to show that a magnetic field cannot be due to an irrotational flow of the ether alone. To prove this, consider a straight conductor moving parallel to itself and perpendicular to a uniform magnetic field. There exists a permanent potential difference between its ends. If, however, the field consists of a flow of ether, the effect is the same as if the conductor is at rest, and the direction of the magnetic field shifted through an angle. But this is the case of a conductor at rest in a field, and there is therefore no potential difference between the ends. Hence a magnetic field must consist of some structure across which the conductor cuts. A field may possibly demand a flow of the ether, but, if so, it must carry in it some structure definitely oriented at each point to the direction of flow. Such electrostatic and magnetic fields produce states of motion in the medium, but no bodily flow in it; consequently we ought not to expect an effect to be produced on the velocity of transmission of light through it

The fundamental postulate underlying this explanation of electric action is that when two different kinds of matter are brought into contact a distribution of vortex filaments in the neighbourhood takes place, so that a larger number stretch from one to the other than in the opposite direction—the distinction between positive and negative ends being that already indicated. To see how such a distribution may be caused, let us consider each vortex atom to be composed of a vortical mass of our secondary medium or cell-structure ether. The atom is much larger than a cell, and contains practically an infinite number of them. It is a dynamical system of these cells with equilibrium of energy throughout its volume. The second atom is a dynamical system with a different equilibrium of energy. Where they come into contact there will be a certain surface rearrangement, which will show itself as a surface distribution of energy in a similar manner to that which exists between a molar collection of one kind of molecules in contact with one of another, and which shows itself in the phenmenon which we call surface tension. In the present case the effect may take place at the interface of two atomic systems in actual contact, or be a difference effect between the two interfaces of the ether and each atom when the latter are sufficiently close. The surface effect we are now considering shows itself as contact electricity. Such a distribution of small vortex filaments, stretching from one atom to another, will tend to hold them together. We therefore get an additional cause for aggregation of atoms. This does not exclude the others already referred to. They may all act concurrently, some producing one effect, some another—one combining. perhaps, unknown primitive atoms into elements, one elements into chemical compounds, and another producing the cohesion of matter into masses.

On this theory, the difference between a conductor and a dielectric is that in a dielectric the ends of the filaments cannot pass from atom to atom, possibly because the latter never come into actual contact. In a conductor, however, we are to suppose that the atomic elements can do so. When a current is flowing, a filament and its equivalent hollow stretch between two neighbouring atoms, they are pulled into contact (or their motions bring them into contact), the hollow disappears, and the rotational filament joins its two ends and sails away as a small neutral vortex ring into the surrounding medium, or returns to its function as an ether cell. The atoms, being free, are now pulled back to perform a similar operation for other filaments. The result is that the atoms are set into violent vibrations, causing the heating of the conductor. When, however, the metal is at absolute zero of temperature there is no motion, the atoms are already in contact, and there is no resistance, as the observation of Dewar and Fleming tends to show. Further, as the resistance depends on the communication of motion from molecule to molecule, we should expect the electrical conductivity of a substance to march with its thermal conductivity. Again, on this theory the resistance clearly increases with increase of distance between atoms—*i.e.*, with increase of temperature. On the contrary, in electrolytic conduction the same junction of filament ends is brought about, not by oscillations of molecule to molecule, but by disruption of the molecule and passage of atom to atom. In this case conduction is easier the more easily a molecule is split up, and thus resistance decreases with increase of temperature. To explain the laws of electrolysis it is only necessary to assume that the strength of all filaments are the same. A similar hypothesis, as we have seen, lies at the basis of J. J. Thomson's explanation of chemical combination, although it is not necessarily the case that we are dealing with the same kind of filaments. It is evident that the theory easily lends itself to his views as to the mechanism of the electric discharge through gases. The *modus operandi* of the production of the mechanical forcive on a conductor carrying a current in a magnetic field and of electro-dynamic induction is not clear. Probably the full explanation is to be found in the stresses produced in the ether owing to the deformation of the cells by the passage of the filaments through them. The fluid moves according to the equation of continuity without slip, and subject to the surface conditions at the conductors. This motion, however, distorts the cells, and stresses are called into play. Any theory which can explain the mechanical forcives and also Ohm's law, must, on the principles of the conservation of energy, also explain the induction of currents.

The magnetic rotation of the plane of polarisation of light does not depend on the structure of the ether, or on the magnetic field itself, but is a result of the atomic configuration of the matter in the field modified by the magnetism. It is generally recognised as caused by something in the field rotating round the direction of the magnetic lines of force. Now, the vortex atom, as usually pictured, is incapable of exhibiting this property. It is, however, an interesting fact, and one which I hope to demonstrate to this section during the meeting, that a vortex ring can have two simultaneous and independent cyclic motions—one the ordinary one, and another which is capable of producing just the action on light which shows itself as a rotation of the plane of polarisation. The motion is rather a complicated one to describe without a diagram, but an idea of its nature may be obtained by considering the case of a straight cylindrical vortex. The ordinary straight vortex consists, as everyone knows, of a cylinder of fluid revolving like a solid and surrounded by a fluid in irrotational motion. In the core the velocity increases from zero at the axis to a maximum at its surface. Thence it continuously decreases in the outer fluid as the distance increases. Everywhere the motion is in a plane perpendicular to the axis. Let us now consider a quite different kind of vortical motion. Suppose the fluid is flowing along the core like a viscous fluid through a pipe; the velocity is zero at the surface and a maximum at the axis Everywhere it is parallel to the axis, the vortex lines are circles in planes perpendicular to the axis, and concentric with it. Since the velocity at the surface of the core is zero, the surrounding fluid is also at rest. Now superpose this motion on the previous one, and it will be found to be steady. If a short length of this vortex be supposed cut off, bent into the shape of a circle and the ends joined, we shall have a very rough idea of the compound vortex ring of which I speak. I say a very rough idea, because the actual state of motion in a ring vortex or a Hill's vortex is not quite so simple as the analogy might lead one to think.

Now, a compound vortex atom of this kind is just what we want to produce rotation of the plane of polarisation of light. The light passing through such a vortex has the direction of vibration twisted in the wave front. In ordinary matter no such rotation is produced, because the various atoms are indifferently directed, and they neutralise each other's effects. Let, however, a magnetic field be produced, and they will range themselves so that, on the average, the primary* circulations through the apertures will point in the direction of the field. Consequently the average direction of the secondary spin will be in planes perpendicular to this, and will rotate the plane of polarisation of any light whose wave front passes them. The rotation is produced only on the light which is transmitted through the vortex. The rotation observed is a resultant effect. In fact, it is clear that in the case of refraction the optical media belong to the type in which every portion transmits the light, and not to the type in which refraction is produced by opaque bodies embedded in the ether. The atoms are only opaque if they contain vacuous cores. The question of the grip of the particles on the ether does not enter, but difference

* "Primary" refers to the motion as usually understood; "secondary," to the superposed, as explained above.

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of quality—showing itself in refraction and dispersion—is due to difference in average rotational quasi-elasticity produced by the atomic circulations, and possibly absorption is due to precessional and nutational motion set up by the secondary spins. These, however, are perhaps rather vague speculations.

Instead of attempting to invent ethers, to deduce their properties from their specifications, and then seeing whether they fit in with experience, we may begin half way. We may assume different forms for the function, giving the energy of the medium when disturbed, apply general dynamical methods, and distinguish between those which are capable of explaining the phenomena we are investigating and those which are not. Invention is then called upon to devise a medium for which the desired energy function is appropriate. This was the method applied by MacCullagh to the luminiferous ether. He obtained an algebraical form of the energy-function which completely satisfied the conditions for a luminiferous ether; its essential property being that the energy depended only on the rotational displacements of its small parts. He was unable, however, to picture a stable material medium which would possess this property. We recognise now that such a medium is possible if the rotational rigidity is produced by intrinsic motions in the small parts of the medium of a gyrostatic nature. In a most masterly manner Larmor has recently investigated by general dynamical methods the possibility of explaining electric and magnetic phenomena by means of the same energy function. Electric lines of force are rotational filaments in the ether,* similar in fact to those I suggested at Bath, whilst a magnetic field consists of a flow of the ether. The same difficulty in accounting for electro-dynamic induction arises, but the general form of the equations for the electro-dynamic and magnetic fields are the same as those generally received. Towards the end of this paper he is led to postulate a theory of electrons whose convection through the ether constitutes an electric current. Two rotating round each other are supposed to produce the same effect as a vortex ring. The mass of ordinary matter is attributed to the electric inertia of these electrons. The electron itself is a centre or nucleus of rotational strain. If I express a doubt as to the possibility of the existence of these nuclei as specified, I do so with great diffidence.† Whether they can or cannot exist, however, the general results of the investigation are not affected. Since this paper was published Larmor has read a second one on the same subject before the Royal Society, developing further his theory of the electron. The publication of this will be awaited with interest. It is impossible in an address such as this to go *seriatim* into the numerous points which he takes up and illuminates, because the mathematical treatment of the general question does not lend itself easily to oral exposition even to an audience composed of professed mathematicians. There is no doubt but that this paper has put the theory of a rotationally elastic ether—and with it that of a fluid vortex ether—on a sounder basis, and will lead to its discussion and elucidation by a wider circle of investigators.

One further class of physical phenomena yet remains—viz., those of gravitation. The ether must be capable of transmitting gravitational forces as well as electric and optical effects. Does the rotational ether give any promise of doing this? No satisfactory explanation of gravitation on any theory has yet been offered. Perhaps the least unsatisfactory is that depending on the vortex atom theory of matter, which attributes it to pulsations of hollow vortex atoms. But this necessitates that they should all pulsate with the same period and in the same phase. It is very difficult to conceive how this can happen, unless, as Larmor suggests, all matter is built up of constant elements like his electrons, whose periods are necessarily all alike. It is possible that the vortex cell theory of the ether, of which I have already spoken, may suffice to explain gravitation also. The cells, besides their rotational rigidity, have, in addition, as we saw, a peculiar elasticity of form. To get an idea of how this theory may account for weight, let us suppose the simplest case where all the cells are exactly alike, and the medium is in equilibrium. Now suppose one of the cells begins to grow. It forces the medium away on all sides; the cells will be distorted in some definite way, and a strain set up. Further, this strain will be transmitted from the centre, so that the total amount across any concentric sphere will be the same. Stresses will therefore be set up in the whole medium. If a second cell begins to grow at another place it will produce also a state of strain, the total strain depending on the presence of both. The stresses called into play in the medium will produce a stress between the bodies, but it is questionable whether it would be inversely as the square of the distance. Whether it would be an attraction or repulsion can only be determined by mathematical investigation. The problem is quite determinate, though probably a very difficult one, and would be of mathematical interest quite apart from its physical importance. Since apparently the phenomena of gravitation have no direct interaction with those of light and electricity, whilst the mind rejects the possibility of two different media occupying the same space, we seem driven to look for it in an independent structure of the same medium. Such a structure is already to our hands, with its effects waiting to be determined. It may well be that it may prove to be the cause we are seeking.

The rapid survey I have attempted to make is no doubt a medley of suppositions and inferences combined with some sound deductions. This is the necessary consequence of a prospecting survey in a region whose surface has been merely scratched by pioneers. My object has been to show that this theory of an ether based on a primitive perfect fluid is one which shows very promising signs of being able to explain the various physical phenomena of our material universe. Probably—nay, certainly—the explanations suggested are not all the true ones. Some will have to be given up, others modified with further knowledge. We cannot proceed to particularise in our secondary hypotheses until we know more about the properties of such media as we have been considering. Every special problem solved in vortex motion puts us in a position to form clearer ideas of what can and what cannot happen. The whole question of vortex aggregates and their interactions is practically untouched, and a rich field is open for mathematical investigation in this portion only of the subject. In all cases, whether a fluid ether is an actual fact or not, the results obtained will be of special interest as types of fluid motion. It is at present a subject in which the mathematicians must lead the attack. I shall have attained my object in choosing this subject for my address if by it I can induce some of our younger mathematicians to take it up and work out its details.

ON SOME NEW METHODS FOR THE DELINEATION OF ALTERNATE-CURRENT WAVE-FORMS.*

BY JAMES MARK BARR, W. BECKIT BURNIE, AND C. RODGERS, B.SC.

With the progress of alternate-current research it becomes more and more necessary to have a reliable, rapid, and accurate means of determining the wave-forms of currents and potential differences. The method now generally in use—namely, the determining of a number of points on the curve and subsequent drawing of a line through these points—though accurate, is tedious, and requires a skilled experimenter. What we need is an apparatus which will automatically record the shape of the wave.

Some years ago Dr. Frölich attempted to use an optical arrangement for showing the shape of the wave. This apparatus consisted of a telephone receiver, the coil of which carried the alternating current, and to the diaphragm of which a mirror was fixed. The diaphragm vibrated with the variations of the current, and a beam of light reflected from the mirror at any moment indicated by its deflection the intensity of the current in the coil of the receiver. This beam of light fell upon a revolving mirror, which imparted to it an independent motion at right angles to that due to the vibrations of the telephone diaphragm. By this means there was traced upon a screen a luminous wave-form. Had this arrangement worked satisfactorily, the wave-form could have been photographed and a permanent record instantaneously obtained, but it was rendered totally useless for ordinary frequencies by errors due to the inertia of the moving parts.

This morning we propose to describe an apparatus which we believe overcomes these difficulties, and automatically records with great rapidity the wave-form. We employ a combination of two motions at right angles of a spot of light relatively to a screen; an ordinary contact disc is used, but the contact brush is slowly and continuously moved through its successive angular positions. Contact is thus made each time at a slightly different position of the armature. Thus, the potential difference at each contact differs slightly from that at the preceding contact. This potential difference is used to charge a condenser across the terminals of which is connected either a reflecting electrometer or a high-resistance galvanometer. The deflection of the instrument so used follows the value of the potential difference of the wave-form to be determined, and accurately follows it, for the mean rate of variation of the potential difference between the terminals of the condenser is exceedingly small in comparison with the rate of change of the E.M.F. to be investigated. This deflection gives us one of the component motions. The other motion of the light spot is made to be proportional to the angular movement of the contact brush.

Fig. 1 shows the arrangement of the contact disc and accessories, a galvanometer being used, for which an electrometer might be substituted. In this diagram, for the sake of clearness, the vulcanite foundation work is omitted and the brass only shown. Our motor having four poles, we have used two knife-edge contacts placed diametrically opposite, which give us one contact per wave. D_1 is the contact disc, which is rigidly fixed to the shaft of the dynamo or motor, and to it are attached the knife-edges just mentioned. The rings, D_2 and D_3, and the rods and brushes, B_1 and B_4, are mounted on one piece of vulcanite loose upon the shaft, and are revolved slowly. The brush B_1 is joined to the ring D_2, with which the brush B_2 is in permanent connection, so that when the brush B_1 makes contact with the knife-edges the condenser, C, is charged to the potential difference between the terminals, T_1 T_2. The con-

* The necessity that the filaments shall be in pairs does not seem to be recognised. This is, however, essential. Moreover, if the complementary circulations of the filaments between, say, a plate condenser be placed otherwhere than in the same region, the filaments, between the plates must rotate as a whole—that is, an electric field would always be combined with the magnetic one.

† It would appear that the same results would flow if two particles oppositely electrified—*i.e.*, joined by two complementary filaments, as already described—were to rotate round each other.

* Paper read at the meeting of the British Association at Ipswich.

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denser is throughout the whole revolution of the disc D_1 discharging through the galvanometer, G, by way of B_3, B_4, B_5, and the resistance, R. As the brushes, B_1 and B_4, are moved slowly round, a succession of charges passes through the galvanometer, the value of each of which is proportional to the instantaneous E.M.F., and the required movement of the galvanometer is obtained. The relative movement of the spot of light at right angles to that due to the galvanometer may be produced in a variety of ways—by a moving screen, by a revolving mirror, or, as in the apparatus which we have constructed, by an oscillating mirror. This mirror is shown in Fig. 2, which is a plan of the general arrangement, and is marked M. Mechanically connected with the disc, D_2 D_3 (Fig. 1), and moving with the same angular velocity, is a cam, marked K, which is shown in Fig. 2. The mirror, M, is pivoted about a horizontal axis, and is oscillated by the arm, *a*, which bears on the cam. The arm is kept pressed against the working edge of the cam by the spring, S. If the edge of the cam is properly shaped, the horizontal motion of the spot of light in synchronism with the angular motion of the brush is obtained.

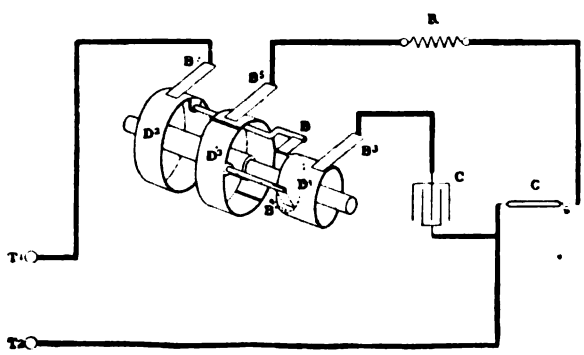

FIG. 1.

We have now two motions at right angles, and by combining them during the oscillation of the mirror, M, in one direction we cause the spot to trace out a wave-form on the screen, P. The spot of light, however, during the return oscillation would trace the wave reversed, and interfere with the true wave image. In order to prevent this, the ring D_3 (Fig. 1) is discontinuous, so that the brush B_5, during the return oscillation, breaks contact with the galvanometer circuit, and the spot draws the zero line. By placing a piece of sensitised paper or a sensitive plate on the screen a permanent record of the course of the spot is obtained. The angular velocity of the moving brushes may be made so small that a well-damped instrument even of long period may be used. For use with an ordinary electrometer, the plane mirror may be made to oscillate about a horizontal axis and a curve drawn, the zero line of which is vertical. The cam may be dispensed with, and the screen itself moved either horizontally or vertically with gearing, or a cylinder covered with sensitive paper may be attached to the

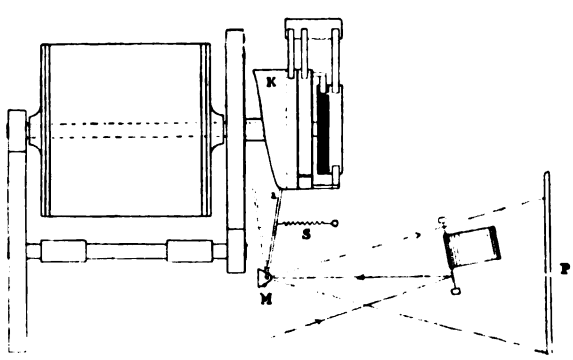

FIG. 2.

moving brushes, and the deflection of this made to move the spot axially on the cylinder. But there are certain disadvantages attached to this method of experimenting which made us decide to construct the apparatus with the cam. There have been brought out lately several methods for building up current and E.M.F. wave-shapes. In using this apparatus during the process of building up wave-forms, the required shape may be drawn upon the screen and the course of the spot of light observed, it being noted wherein it differs from that curve, and steps being taken to ensure a close coincidence. With the form of apparatus in which the cam is not used, this process is more difficult.

A short time ago Dr. Fleming published a new and ingenious method of plotting wave-forms with polar co-ordinates, and of directly obtaining therefrom the root mean square value. Our apparatus may be easily modified so as to obtain a record of one of these polar waves. For this purpose, the slow-moving disc must be mounted on the extreme end of the shaft, and a sensitised screen must be fitted thereon. The instrument must be so placed that the zero position of the spot of light is on the centre of the disc and the deflection along one of the radii. The curve traced will then be of the required form. By a system of mirrors it would be possible to obtain the same result with the screen fixed, but this appears to offer no special advantages.

The galvanometer which we have up to the present used with our apparatus is of the Ayrton-Mather type with a horizontal coil, but no silver tube for damping. The coil is wound with 260 turns of wire, 1·4 mils in diameter, with a resistance of 400 ohms. The period is small, being about ten-fiftieths of a second. The damping is effected by a light glass arm dipping into an oil vessel, the height of which can be adjusted. An electrometer would have been preferable, but it is difficult to obtain an electrometer of sufficiently small period. For tracing the wave very slowly an electrometer may be used, but one of the advantages of our method over the methods in ordinary use is the rapidity with which the wave may be traced. In many experiments there is a variation of speed with time, against the effects of which it is necessary to guard, but in tracing a wave in a few seconds no appreciable variation of speed can take place. We have here a photograph of a potential difference wave-form taken by means of this apparatus. As the experiments were performed after the closing of the college, the only current available was that from a small four-pole motor transformer. The consequence is that there is a series of steps in the wave due to the commutator segments which were comparatively few in number. This, of course, gives a wave-form not so nice in appearance as an ordinary sine wave, but it is so much the more a severe test of our apparatus.

In determining the curve by the ordinary method the irregularities would not have been so clearly seen unless an exceedingly large number of points had been taken. The spot of light was rather unsatisfactory, there being a small auxiliary spot by the side of the main spot. This small spot traced a

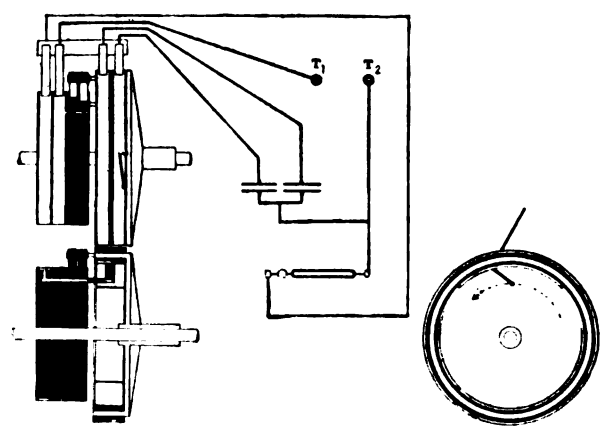

FIG. 3.

curve itself which can be distinctly seen on the photograph, and which detracts somewhat from the clearness. We should much have liked to show a smooth wave-form taken with this apparatus and a satisfactory spot of light, but the constructive work was finished only last Saturday, and we have not had time to perform many experiments with it. If the spot of light were made to trace out the wave-form sufficiently rapidly, the curve would appear as a continuous luminous line. This can be effected with the apparatus as it now stands with high frequencies. With low frequencies, however, that is impossible. For instance, with a frequency of 80 alternations per second we obtain 80 contacts per wave. But since, for the line to appear continuous, the slow-moving disc must make at least five revolutions per second, the number of contacts cannot exceed eight per complete period, or four per half wave—an obviously insufficient number.

We have here (Fig. 3) a diagram illustrating a method by which this difficulty is overcome. As before, the apparatus consists of two discs—one moving at the speed of the motor and the other a slow-moving one. The slow-moving disc carries two collecting rings, two brushes, and an internal four-part commutator. Each collecting ring is connected to a pair of opposite commutator segments, and the slow disc carries two brushes which bear on the fast disc and are connected one to each collecting ring. The fast disc also carries two collecting rings, one connected to the knife-edge and the other to the fast-revolving brush which bears on the four-part commutator of the slow-moving disc. The two brushes carried by the slow-moving disc are slightly in advance the one of the other, and the slow-moving disc is rotated so as to have a definite speed relation to the fast disc. The two condensers are charged in rapid succession as the knife-edges pass the brushes, and during the remainder of the half revolution are discharged in succession

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through the four-part commutator, the fast-revolving brush, and the galvanometer. The effect is to get twice as many discharges through the galvanometer per wave as is obtained with the apparatus shown in Fig. 1. Three or more condensers can be used, the total number of contacts per wave obtained being proportional to the number of condensers used. For all ordinary purposes, however, the apparatus with one condenser will be found most convenient.

In conclusion, we must acknowledge our indebtedness to Prof. Ayrton and Mr. Mather for their kind advice, and to Mr. W. Duddell, one of our fellow-students, for his help during the construction of the apparatus.

INDIAN THUNDERSTORMS.*

BY PROF. MICHIN SMITH.

The author's experience has been most gained in the Madras district. At certain seasons of the year a marked constant recurrence of sheet lightning at dusk was noticed. The display was always near the horizon in the west or south-westerly direction. The author considered the reason of the low position of the lightning is because it takes place in the upper part of the clouds. An overhead storm, then, does not show any display of lightning. Analysing the matter further, he found that the wind was usually off the land all day, and that the time at which storms occurred varied with the time at which the S.W. wind springs up off the sea. If this is late, the storm is late, or does not occur at all. The conclusion from this is that the storms occur where the land and sea winds meet. The land winds are usually dry and more or less dusty, while the sea-breezes are moist. The author exhibited some good photographs of the two parallel clouds formed where the winds met. The frequency of the lightning flashes between the clouds was very high, often exceeding 150 flashes per minute. The author considered that the winds from the land were usually highly electrified negatively, and that the sea-breezes were positively electrified. These storms do no damage, as the whole of the discharges are aerial or between clouds.

COMPANIES' MEETINGS AND REPORTS.

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

The sixth annual general meeting of this Company was held on the 23rd inst., at Cannon-street Hotel, E.C.

The **Chairman** (Mr. J. B. Braithwaite, jun.), who presided, in moving the adoption of the report and accounts (a copy of which appeared in our last issue), referring first to the balance-sheet, called attention to the fact that the amount of the Company's capital remained unchanged, while the creditors had been reduced during the year from £72,000 to £44,888 ; but the loans and overdrafts from bankers had increased from £25,000 to £78,000. The provision for depreciation on property, patents, and goodwill remained the same as last year. The contingent liability in respect of uncalled capital had been reduced from £39,697 to £5,547, which was not likely to be called up, and had, therefore, practically disappeared. On the other side of the account the item of property, patents, and goodwill had been increased by £2,487 by additions to plant during the year, and now stood at £288,874, after deducting the usual sum for amortisation of lease. Having referred to other items in the balance-sheet he remarked that the chief item which would attract their attention was the increase of the loan from the bankers from £25,000 to £78,000. Of this difference £27,000 was owing to their having reduced the amount due to their creditors from £72,000 to £44,888, and the remainder was owing to the increase of their shares and debentures in other companies, practically representing the difference between the £39,697 liability on shares they had last year and the £5,547 which they now had. Their gross profit for the past year had been £37,858, being nearly £20,000 less than that of the previous year. This decrease was owing entirely to the difficulties which had occurred in connection with their contract with the City of London Electric Lighting Company. On the other hand, their general charges had been £17,020, compared with £19,974 in the previous year. With reference to buildings and plant, their chief engineer, Mr. Raworth, had certified that these had been maintained in an efficient condition. The item of bank interest and commission, £2,227, would disappear on the issue of the additional amount of debenture stock they were now proposing to make. Last year he had stated that the loan of £25,000 from the bankers was likely to be a temporary matter, and, therefore, it was not worth while to issue additional capital to liquidate it. What he said with regard to that applied with equal force to the amount which they now owed their bankers of £78,000, and for that reason they did not propose to make any permanent addition to the capital account of the Company. They would see from the figures he would give them that it would be unwise to saddle themselves with a permanent charge for the additional £105,000 of debenture stock which they proposed to issue. On the other side of the balance-sheet they had assets more or less liquid, and which might easily come in in the form of cash for shares to the amount of £61,000, while the balance of debtors over creditors was £96,000, and the stock was worth £100,000, making a total of £257,000. Of course, he did not hope to see anything like the whole of that sum come into cash, because if they realised the whole of their stock and the whole of the difference between debtors and creditors it would mean that their business had practically come to an end. At the same time the balance of debtors over creditors was very much larger than it would be in a normal year's trading, owing to the fact of the heavy retention funds which they were obliged to allow to remain on some of their municipal lighting contracts. However, it was reasonable to suppose that the balance might be reduced to £50,000, in which case they would have £50,000 in cash, which, in addition to the shares and debentures which they were constantly realising, would give them sufficient to redeem the whole amount of the debenture stock they were now proposing to issue. They proposed, therefore, to make the new stock redeemable at 105 per cent. at six months' notice at any time, and he thought it probable that unless some very unexpected extension of their business took place in the course of the next two or three years the whole or a considerable portion of that debenture stock would be redeemed. With reference to dividend, under the articles of association, the preference shares were a first charge over the ordinary shares to the extent of a full 6 per cent. dividend from the net profits of the year, but they were not cumulative as from one year to another. During this year they had earned £7,400 net, of which the preference shareholders had received £5 400. There was, therefore, another £2,000 odd to come to them which he hoped they would receive next year, in addition to their ordinary dividend of 6 per cent. Having dealt with the accounts and balance-sheet of the Company, the Chairman continued : Of course the first question you will want to hear about is the circumstances in connection with the contract with the City of London Electric Lighting Company, which has unfortunately turned what would have been the best year in the Company's existence into the worst. That only illustrates the disadvantages, in some ways, of having contracts of such very great magnitude. But it may be a matter of satisfaction to the shareholders to know that, apart from the City of London Electric Lighting Company's contract, the past year has been the best in the history of the Company. We have made more profits than we have ever done before, apart from that one contract, and I think it is due to the shareholders to know that, because otherwise they might consider that this large drop in the profits was due to a falling off in our business generally, or, any rate, to our not being able to conduct the business at a profit. This unfortunate result is entirely due to the extraordinary and unforeseen circumstances which have arisen in connection with the contract I have referred to. I do not think I am at liberty to go into exact details, but I think I can give you in very general terms sufficient reasons to enable you to understand the position in which we have been placed. The contract with the City of London Electric Lighting Company was one of considerable magnitude, amounting in all to somewhere about £300,000, and under that contract the decision of all points connected with it was left absolutely to the engineer of the City of London Electric Lighting Company for the time being. That, of course, is a very usual provision, and no doubt would have been perfectly satisfactory under ordinary circumstances, but we have been unfortunate enough to have no less than three engineers in the course of the existence of that contract, each of whom, as he was appointed, became practically a supreme judge as to whether the contract was being carried out satisfactorily or not. Now, I need hardly tell you gentlemen, that among electrical engineers, each has his own particular views, and therefore you will readily understand that the change of engineers which took place in the City of London Electric Lighting Company in December last year was a very unfortunate thing for us when it turned out that the new engineer had very different ideas of what the obligations under the contract were to those which his predecessor had had. We have done the very best we could under the difficult circumstances in which we have been placed. In view of the fact that the engineer is made supreme judge, there was practically no alternative before us but to accept the altered view of what were the obligations under the contract, or resort to an exceedingly expensive lawsuit ; and I hope you will give us credit for having, under the circumstances, made the best arrangement we could, although the result has been to have an exceedingly serious effect upon our profits for the past year. We have therefore endeavoured to adjust matters with the new engineer of the City of London Electric Lighting Company on the basis that he wishes, and that having been accomplished, work under the contract is again proceeding. With regard to the general prospects of our Company, we are in the fortunate position of having our works fully occupied with orders for some months in advance During the year we have carried out and opened central stations for electric lighting for the Municipalities of Worcester and of Leicester, and we have also opened for the County of London and Brush Provincial Company a station for the supply of electricity to Dover. All those works have turned out entirely satisfactorily, and we have work of a similar character in hand in our shops for St. Luke's, Clerkenwell, and Wandsworth,

* Abstract of paper read at the meeting of the British Association at Ipswich.

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for the County of London and Brush Provincial Company, and for various other stations up and down the country, so that as regards the electrical shops we are full of orders and have plenty of work in hand. With reference to our car-shops, we are also full of orders there at the present time. We have been building locomotives and rolling-stock for the Beira Railway, about which undertaking some of you may have heard a good deal; it is one of the new railways that has been constructed for the opening up of South Africa. We have also in hand at the present time a large number of cars for the Rouen Tramways Company, which are being equipped with electricity. With regard to the engine building side of our works, there again we have carried out a considerable number of orders. We have already sold about 35,000 h.p. of engines, and our chief engineer, Mr. Raworth, has just introduced a new enclosed high-speed engine, from which we hope great things in the future. It is an engine which will be equally suited for electrical work and all other kinds of work to which steam-engines are generally put; we certainly hope it will bring considerable additional orders into our engine-shop, and that it will give us an engine which we can manufacture at a very considerable profit. After all, the chief duty we have towards our shareholders is to find articles which, in the present severe state of competition, we can manufacture at a reasonable profit, and we believe this new engine will be one of those articles. With regard to electric traction—for electric traction is a thing that we must look to very largely in the future, to keep our electrical engineering shops full—up to the present time we may say that in Great Britain it has been practically a dead letter. If you go into the United States of America or Canada you will find that even small villages have their electric tramways and electric railways of different kinds. I suppose in the States now there are literally thousands of miles of tramways worked by electricity, whereas in this country the electric tramways which are at present open can be counted on the fingers of one hand. At the same time, the thin end of the wedge has been introduced into this country, and I have no doubt that when the three or four important tramway works that are now in course of construction are opened, and the public realise the immense convenience and the immense acceleration of travel which are due to the adaptation of electricity for the working of their tramways, we shall see a very great rush of electric tramway business in this country. With reference to the working of railways by electricity, we have in England two specimens of a railway worked entirely by electricity. These are the City and South London Railway, running from the Monument to Stockwell, and the Liverpool Overhead Railway, both of which are working perfectly satisfactorily, and, as you know, there are two other important electric railways in course of construction, one belonging to the City and South London, and the other the Central London Railway, which will run from Liverpool-street to Shepherd's Bush, by way of Holborn and Oxford-street. These will be worked entirely by electricity, so you see that electric traction, even in this country, is beginning to take hold, and when we read in the American papers that the first locomotive turned out for the Baltimore and Ohio Railroad Company has drawn a freight tram weighing 1,200 tons at the rate of 15 miles an hour, and on a speed test the other day is reported to have attained a rate of 61 miles an hour without any difficulty. I think we may say the electrical industry has an enormous future before it in the direction of electric traction. Electric lighting is a firmly established industry, and is not likely to retrograde, but electric traction offers a comparatively new field, and in that direction I look to a large amount of work for our well-equipped car-sheds at Loughborough. I do not know that there is any other matter to which I need call your attention at present. One subject I might be allowed to mention, and that is that having regard to the position in which the Company has been placed by these unprecedented circumstances in connection with the City of London contract, myself and my colleagues feel it would be the right thing for us to forego half our fees in the ensuing year. That, I think, will indicate our desire to do our best for the Company in every way.

Mr. B. H. Van Tromp seconded the adoption of the report.

Mr. Ward asked whether the directors would endorse the statement that the shares and debentures in other companies to the amount of £60,000 were of full value, as the auditors in their report stated that they had not verified the market value of them. The report presented to the shareholders was the most unsatisfactory one they had ever had. In a trading company one naturally expected every now and then to have a loss, but in this case it was not a loss in trading in the ordinary sense. He could not help thinking that the directors had made a considerable blunder in allowing all matters to be referred to the engineer of the company for which they were doing work. He imagined that there should have been an umpire in case of disputes, instead of leaving it virtually in the power of the people for whom they did work to pay what they liked. Shareholders were naturally anxious to know whether the other contracts which the Company had in hand contained similar stipulations, and he hoped that the directors would be very careful in future as to the manner in which contracts were entered into.

Mr. Lamont asked if the Board could throw any light upon the fact that for a week or two before the issue of the report the shares had been going down.

Mr. Maclean enquired why an interim dividend had been paid on the ordinary shares, when, as it turned out, the preference shareholders were entitled to the whole of the profits.

The **Chairman**, in reply, said that the question of the shares and debentures in other companies was a matter to which both the directors and the auditors had given great attention. Rather more than half the total amount of £61,000—some £35,000—consisted of shares which were quoted upon the London Stock Exchange, and with regard to those he might say he should be considerably disappointed if, when they realised them, they did not make a substantial profit of some £4,000 or £5,000 on their sale. With regard to the remaining £25,000, those shares and debentures were mostly connected with undertakings in which the Company had been interested in the past. He thought he might say that in every case those undertakings were in an improving position, and in many instances the Company were in receipt of dividends from them. In the case of a similar undertaking which stood in their books for some years, they had realised its shares during the past year, and had made a handsome profit upon them. But some of those shares were valuable to the Company apart from their actual market value, inasmuch as they gave them a controlling interest in companies which supplied this Company with orders. He thought he might say that, after very anxious consideration on the point, the Board believed that the shares were well worth the figure at which they stood in the balance-sheet. With regard to the conditions of the City contract, he was not responsible for the negotiation of that contract, which was made before he became chairman of the Company, but he thought it was very probable he should have done the same had he been in the place of their then manager. It was impossible to foresee that they would have a change of engineers three times within as many years, and the circumstances were so extraordinary and unprecedented that he did not think any reasonable amount of foresight could have prevented the present difficulty. He quite agreed that it was a most unsatisfactory form of contract, for he always felt that there was a very real risk in having as sole arbitrator some gentleman who might not be very illustrious in either the electrical or engineering world; but it was the same form as that usually adopted, and was identical with the Company's municipal contracts. He would also point out that if they did not take contracts on those terms, other competitors would be only too glad to get them. With reference to there having been some apparent leaking out on the market of the probable purport of the directors' report, he could only say that this had been a matter of extreme annoyance to the managers and the directors, and to himself particularly. They were engaged in investigating the matter, but as yet without tracing anything. It was extremely annoying, because it seemed to imply that those "in the know" had been taking advantage of their knowledge to realise shares at better prices than would be possible after the report was issued. Naturally, the directors had done nothing such as had been suggested; he personally had increased his holding, because he considered their shares to be much below their intrinsic value. Regarding the interim dividend, of course when that was paid everything was proceeding entirely satisfactorily; the whole of the loss that had arisen had occurred in the second half of the financial year. He imagined the shareholders would desire that no interim dividend should be paid on the ordinary shares in the future; at any rate, that was the course the Board would probably adopt unless the shareholders instructed them to the contrary.

In answer to a question as to whether the Company had any representatives on the Board of the City of London Company, the **Chairman** replied in the negative. Originally, he said, they had two representatives—the late Duke of Marlborough (then chairman of the Brush Company) and himself. When the Duke of Marlborough died, he was not replaced, and he (the speaker), who was then their only representative, felt it his duty to withdraw from the Board of that company, not especially in connection with their contract—although he felt they had been badly treated by the City Company—but because he dissented entirely from the policy the present engineer was carrying out, in the interests of the City of London Company itself.

The resolution was carried, and Messrs. E. Woods and A. Ayres, the retiring directors, were re-elected, as were also the auditors, Messrs. Cooper Bros. and Co.; and the chairman having accepted a suggestion that a circular should be issued to the shareholders about January showing the progress of the Company, the meeting closed with the usual votes of thanks.

HALIFAX AND BERMUDAS CABLE COMPANY, LIMITED.

The report for the year ending June 30 states that the cable receipts were £4,202, as compared with £3,463 in 1893-4, the increase being due to the improvement in the general business condition of the Bermudas. The result of the working was a profit of £1,023, as compared with £329, which will reduce the debit to capital to £3,870. The cable worked with complete efficiency and its electrical condition continues excellent. The directors are glad to be able to announce that they at last obtained the assent of all the holders of the debentures to such a modification of the trust deed as permits of the application of the sinking fund to purchases or drawings. Accordingly offers for the sale of debentures to the trustees were invited in June, when £11,200 of debentures were acquired and cancelled at a cost of £10,216. It is intended to apply the sinking fund in June and December. The reduction of the capital outstanding permits of the extinguishment of the debit to capital account of £3,870, and the writing down of the capital expenditure by £7,330.

Agency.—Girdlestone and Co., of 16, Davies-street, Berkeley-square, London, W., have been appointed sole London agents for Messrs. J. P. Hall and Co., of Blackriding Ironworks, Oldham, for the sale of their specialities in dynamos, engines, turbines, projectors, etc

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TO CORRESPONDENTS.

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BRITISH ASSOCIATION PAPERS.

We have made this week's issue almost entirely a report of British Association papers in order to get rid of all recollections of that meeting as far as possible at the earliest moment. Our readers will be able to judge of the merits of the papers, and no doubt will pick up crumbs of information here and there. It is somewhat unsatisfactory to know that several papers on electrical topics were unread for want of time, and the more so, as some papers were undoubtedly given too much time. Indeed, the whole of the sections seem a little unbusinesslike in this way. A paper read early in the day too often is discussed for a length of time out of all proportion to its value. Our experience—if it is worth recording—is that, on the whole, the discussions on the papers were tame and unprofitable. In 90 per cent. of cases the speakers did not speak to the papers at all, but launched out into some phase of the question wholly unconnected with the paper, and generally without possibility of even the remotest connection with the subject-scope of the paper. This, with all due diffidence in saying it, was due entirely to the various presidents. The difficulty of presiding over a sectional meeting is great, and the difficulties are made greater by laxity of authors and of organisation. If a president is to keep the discussion within touch of the subject-matter of a paper, he must know the subject-matter of the paper; hence he should at any rate be provided with a pretty full abstract, if not with a complete copy of the paper. Under present conditions it is absolutely impossible for the president to become perfectly acquainted with the scope of the paper while it is being read. In the anxiety of each section to get a sufficiency of papers it too often happens that in the end too many are obtained, some of which could have been better unwritten, as they may cause better papers to be thrown out or given in pantomime. Fewer and better papers and real discussions should be the cry, if the British Association is to continue to exist. We do not know whether a plethora of papers in Section A led to the discussion on "Magnetic Units" being postponed to the morning of the last day of the meeting, but such postponement was fatal to real discussion. The set speakers had their say, and that was about all. Many men interested in the question were either absent or refrained from taking part in a discussion that could not possibly lead to anything practical. A catch vote at the end of a meeting in a section where probably fully one-half the few hearers had neither part nor parcel in the question, is not a good way to induce English or foreign writers to accept the suggestion of new units. Again, we might ask if Section A is *the* section to put even the suggestion to the vote? As we understand it, Section A is composed largely of doctrinaires—largely of students who sit at the feet of learned Gamaliels, and have no views save those of the Gamaliels at whose feet they sit — while Section G is composed far more largely of practical men—men who have had experience in carrying out large works and of organising factories. It is just

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possible that the members of Section G could say, We do in practice feel the need of this or that unit, of this or that definition; while all that Section A can say is, You ought to feel the need of it. In our view, then, the suggestion of an extension or change of units should not be the work of one section, but the combined work of all the sections which are interested, theoretically or practically, in the subject. Section A should have combined with Sections C and G in this matter. We are not here entering upon a discussion of the desirability or the undesirability of new units, new substantives, or new definitions. We are simply concerned with the question whether, as carried out under the auspices of Section A at Ipswich, the matter brought forward by Dr. Lodge is advanced. Further, we are somewhat of the opinion that the British Association has lost the lead in this matter. Several international congresses have been held and international agreements made. It seems, then, that if extensions are to come, the extensions should be the result of further international agreement before being recommended for adoption. There would be no objection, perhaps, to the British Association recommending certain new departures to the next international congress, whenever and wherever that may be. If, as one or two speakers suggested, the whole of the present system has to be thrown overboard sooner or later, what is the use of tinkering? These academic discussions may or may not add to the reputation of individuals, but, like a good many other things of an academic nature, they have no permanent value.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MUNICIPAL ELECTRICAL ENGINEERS.

SIR,—The first few opening lines of the leading article in your current issue on the above subject led me to anticipate some little support from your journal for our newly-formed association, especially when I had reached the point where you claim to have previously advocated the formation of such an association.

Your argument from that point, however, renders the title an absolute misnomer, for the remainder of the article savours very strongly of personal attack, notwithstanding the "saving clause" at the end.

Let me say at once, as one of the municipal electrical engineers, that I consider this portion of your article most inopportune. You have entirely overlooked the fact that the secretary is appointed *pro tem*, and whether or no one may agree with you that as a permanent appointment the official should be above suspicion and entirely unconnected with trade, the personalities introduced into your argument are beside the point, and are not only to be regretted, but condemned. In the case to which you allude no error has been committed, as you surmise. On the contrary, the committee were unanimous that no other person could so well serve the immediate interests of the association as the gentleman appointed. In this decision, although as yet I have had nothing to do with the association, nor was present at the meeting, I entirely concur; and the gentleman in question, in accepting the appointment, gives an advantage to the association which is of the utmost importance in this stage of its existence. Again, your insinuating assumptions of child-like innocence, on the one hand, and of utter unscrupulousness, on the other hand, are so painfully hypercritical as to disgust the readers for whose edification (?) it is intended. For instance, I have yet to know the committee and the member of it who could possibly make the engineer's life a burden, let alone a shame, because he belonged to an association whose secretary was connected with some trade concern. If an engineer, municipal or otherwise, were not perfectly straight in his business dealings his life would be a burden and a shame under any circumstances, but the direful possibility you conjure up is, thank goodness, no more than a grossly ludicrous idea.

Are you aware that municipal electrical engineers do not conduct their business, nor entirely exist, to please individual members of their committees? There are higher considerations by far which regulate their actions and assign to them their value, but of such things your article writer appears to be an entire stranger.

Municipal electrical engineers must feel deeply indebted to your opinion of them, and will, I am sure, anticipate further help of a similarly disinterested character.

In conclusion, I do not think municipal electrical engineers "less used to the ways of this wicked world" than are men of other professions, or they would be taking your article as written purely in the interest of themselves and their association.—Yours, etc., ALFD. H. GIBBINGS.

[This letter of Mr. Gibbings's is delightful. It shows our article touched a sore, and has caused some wincing. Perhaps Mr Gibbings will enlighten the public, and especially the councils which engage and employ electrical engineers, how it comes that a man wholly unconnected with municipal work, except as a commercial traveller to sell goods, comes to be mixed up officially with the formation of a municipal electrical engineers' association? When we find a bank manager mixed up with the formation of what purports to be an important company, it requires little foresight to know his reasons for being so mixed up. Does Mr. Gibbings imagine the "wicked world" is for a moment misled by the term "secretary *pro tem.*"? It wants to know, you know, what business an outsider has in the councils at all, and why he who cannot well know the "higher considerations by far which regulate their actions and assigns to them their value," because he is an outsider and not an insider, is to formulate and guide the actions of the embryo society. Mr. Gibbings's letter shows that his knowledge of the ways of this wicked world is comparatively small. When he has had a few more years' experience of the funny doings of councils and committees he will probably be able to tell another tale. But enough of this banter. Mr. Gibbings may think what he pleases, but the fact remains that an outsider has been appointed—*pro tem.*, if you like—and such appointment was an error. As for ourselves, we have no personal bias one way or the other. We know there is a deep-rooted objection among municipal electrical engineers to the course pursued, and we have given effect to the views of a large number of such engineers.—ED. *E. E.*]

SIR,—With reference to your leader upon "Municipal Electrical Engineers," published in your number of September 20, 1895, as you remark, the subjects that interest the central-station engineers and their assistants are such as can only be discussed properly by members having no trade connections whatever, and all the members must be free from any taint of being connected with any house in the trade; but there would, in my opinion, be no objection to any officers of a technical paper becoming members of such a society.

The gentleman to whom you allude, in conjunction with myself, discussed the question, and the matters above referred to were fully appreciated by us at the time; but the question of starting such a society required someone in a position to feel the pulse of my brother engineers, and this thankless task was accepted by our friend under discussion, but with the knowledge that when the society was under way, he would retire as a matter of course. It is very exceptional to find one of our kidney capable of sparing the time to promote in this manner such a society.

For the sake of the engineers who are not yet aware of the proposals that are in the air, and also to elicit an expression of opinion upon the matter, I will briefly state the principal features discussed so far, and which have met with cordial support:

1. That the society shall meet during the year a given

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number of times to be determined upon, on each occasion at some town or district, with the idea of viewing an electricity works.

2. That the chairman shall be the chief engineer or manager of the electricity works to be visited on such occasions.

3. That a dinner shall wind up the day, for which each member shall contribute his share of the expenses—the chairman being entertained by the remainder of the members.

4. Discussion to be absolutely under the control of the chairman.

5. No set papers, but criticisms to be made, if possible, upon the works lately under inspection.

6. The society to be empowered to order the printing of any details of interest and to circulate them amongst its members, orders for such to be carried by vote at one of such meetings.

There are a lot of other questions, of course, that require discussion, but such questions should be left over until a meeting of the society took place.

With a view of clearing the ground to a certain extent, and also to bring the matter to a head, I suggest that a committee of, say, four members of our profession, be chosen to confer together, and to issue the necessary circulars, with a view of bringing the matter under the notice of all our brothers, and to accept and appoint as members *pro tem.* all chief engineers or managers who apply for membership. When the further details as to subscriptions and mode of procedure shall be determined upon, then all applications for membership from assistants shall be taken into consideration. Any *pro tem.* member not withdrawing at this time shall be considered a member, and to be liable to the subscription arranged to be paid.

It will be seen that, owing to the proposed arrangements for the society's meetings, etc., the subscription should be merely nominal, as any expenditure will be voted upon by all the members at their meetings before the dinner, as then the business will not be unnecessarily delayed. The expenditure in the case will be entirely under the control of the members.

I hope, Sir, that this question will receive the support from all my brother-workers that I believe the subject merits, and that the discussion, if any, that may arise will promote the object in view.

I shall be pleased to receive letters from any electricity works managers or chief engineers, with any suggestions they would like to make upon the subject, and whom they, in their opinion, think would be the best four members, being all engineers or managers of electricity works, who would be likely to meet their views as regards the formation of the society; I will then analyse the names, and will write to those four receiving the greatest support, and try and arrange a meeting to take place as soon as possible.

I have taken the initiative in this matter well knowing that many members of our profession are much more competent to deal with it than I am. At the same time I shall be only too pleased to do all in my power to advance its prospects.—Yours, etc., J. E. STEWART.

Corporation Electric Lighting Station, Full-street,
Derby, September 25, 1895.

[Mr. Stewart having taken a keen interest in this matter, why not, instead of waiting for letters, take the further action and ask, say, Messrs. Baynes, Hesketh, and Talbot, as men of a representative character, to confer with him, and prepare a circular to be sent to all municipal electrical engineers.—ED. *E. E.*]

SOME USES OF CURVES IN ELECTRICAL PRACTICE.

BY H. H. SIMMONS, A.I.E.E.

(Continued from page 243.)

A further use for the straight line O I is at once obvious. If we have a dynamo whose characteristic is given by the curve V, in Fig. 13, we can very readily find what the dynamo will do when working on a given resistance by drawing such a line, O I, as will represent that resistance. The effect of any change in resistance is equally quickly seen.

Being in possession of the characteristic curve, O V, we can draw lines to represent resistances of, say, 3·5, 4, and 5 ohms—viz., I_0, I_1, and I_2—and we find these cut the curve at the points P_0, etc., respectively, showing that when the dynamo is working on these resistances it will give 42 volts 12 amperes, 45 volts 11·25 amperes, and 50 volts 10 amperes respectively. The lines I_3 and I_5 show that we can get 56 volts with a current of either 4·2 or 8·2 amperes, according as the resistance is either 13·3 or 6·82 ohms. The maximum of 59 volts is obtained on a resistance of 9·83 ohms with a current of six amperes.

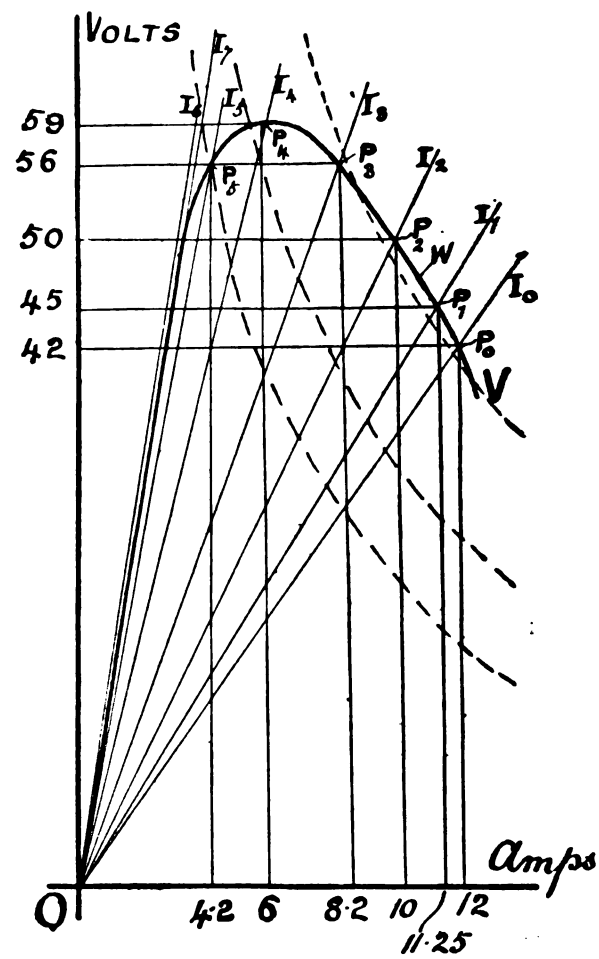

FIG. 13.

I_7 is seen as a straight line coinciding with a considerable length of the curve; this shows the resistance represented—viz., 15·5 ohms—to be an unsuitable one, or rather that the dynamo will not work well on it; the conditions being obviously very unstable when any current and voltage, from nothing up to 3·2 amperes at 49·5 volts, can be obtained from the machine on this one resistance. Also, any drop in speed would have the effect of stopping all current in the circuit. This is seen by reference to I_6, which represents a resistance of 14 ohms and which lies right outside the curve, not cutting it in any point at all. Now any decrease in speed lowers the whole characteristic, for with a given current flowing in the magnet coils and armature the internal E.M.F. will be directly proportional to the speed, since the field resulting from the magnets and armature will be the same for the same current. To obtain a new characteristic from the old for a new speed, therefore, we have only at every point to add the volts wasted in the machine to the terminal volts at the first speed, and reduce this total internal E.M.F. in proportion to the speeds, and then again deduct the volts used in the machine. This will give us the terminal voltage at every point for the new speed: If the speed be less, the voltage at every current value will also be less, and this will throw I_7 into the same condition as I_6—viz., right outside the curve. From this we see that if we are working on a resistance at the position of I_5 we run the risk, in the

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event of a drop in speed, of having a total stoppage of current in the circuit until the speed again rises.

The dotted curves are curves of constant horse-power—*i.e.*, the product of the volts and amperes at any point or all points on one of these curves is the same. The point of maximum power is evidently about the region of the point W.

(To be continued.)

NOTES ON A RECENT DEATH FROM LIGHTNING STROKE AT SHOEBURYNESS, ESSEX.

BY DAVID T. KEY, M.R.C.S. (ENG.), L.S A., SURGEON-CAPTAIN VOLUNTEER MEDICAL STAFF.

During the recent meeting of the National Artillery Association at Shoeburyness, where I was doing duty as camp surgeon, the following fatality occurred. On Tuesday, August 6, 1895, at 6.50 p.m., a man, whilst walking with a female companion along the footpath leading from South Shoebury to Shoeburyness railway station, was struck by lightning and killed instantly. He was a London cab-driver, single, aged 30, had been in the army, and was an army reserve man at the time of his death. The footpath is about 6ft. in width, having on one side a shallow ditch and a row of tall old elm trees, and on the other an iron railing about 5ft. high, the rails forming a row of pointed spikes 6in. long above a horizontal bar. The tree nearest to the deceased was the last of the row. It was to the man's left hand, and the woman was between him and the railings They were walking. There had been no rain for about three-quarters of an hour. Deceased was perfectly dry. I saw him within four minutes of his death. He had fallen on his face diagonally across the path, with his head towards the tree. His face was livid and suffused with blood. His eyes were closed; yellow mucus was exuding. He was quite dead, so I had him placed on a small ladder and removed at once, as there were still frequent flashes of lightning, a possible source of danger to onlookers. There was probably a rise of temperature, for I observed the body was very warm to the touch, and there was a very powerful smell of burnt hair and flesh. His companion was thrown against the railings, but did not fall. She was able to answer my questions, but was very pale. She said she felt heat on the left side of her face. Her left ear was filled with *debris* of hair. On examining the body at 8.30 a.m. next morning, in conjunction with Surgeon-Colonel Coats, A M.S., garrison surgeon, the body was found to be well nourished, muscular, and well developed. Rigor mortis was well marked. On examining the head the point of probable entrance of the electric fluid was found to be at the vertex, almost central; slightly to the left of the central line showed an oval excavation in the hair about 1in. No wound was apparent. The hair was all singed short over the left side of the head. The left eye brow, eyelashes, and left side of the moustache were practically gone. Fluid was escaping from the left ear. On tracing the burns on the left cheek and under the left lower jaw several large ones were found on the left thorax and sternum; thence centrally over the abdomen. The hair of the pubes was all singed short; the scrotum was swollen and livid; thence along the inner side of the right thigh and calf over the internal malleolus, the point of exit of fluid being at the inner and central point of the right heel. The burns were of various sizes and interrupted, the largest being that on the sternum, about 1½in. in diameter. The surface of the burns was dried. The epidermis was entirely destroyed and gone. On examining the clothing, the hat was found to be in small shreds, but the coat and waistcoat were very slightly damaged A blue woollen jersey was not much damaged. The shirt (grey flannel) was split in the same direction as the burns, and a merino undervest next the skin was split in the line of the burns two-thirds from above downwards—the edges of this crumbled when handled, but were not charred black. There was a hole through the watch pocket. The trousers were split into long vertical ribbons in both legs, but more especially along the line of burns. The right pocket was blown to shreds (there had been about 14s. silver money in this, which was picked up at the time of removing the body). The drawers were very much torn. The boots were of the front lace-up pattern, the soles and heels of which were entire, but some brass nails had started in the sole of the right boot. Half of the inner uppers of each boot was entirely gone; also the metal eyelet holes. The right boot was blown off the foot entirely at the time of the accident. The collar and cuffs were in shreds. The necktie (a bow) was split in two in the middle. The tree showed a spiral interrupted track of the lightning, the bark being broken off The lightning apparently left the tree about 10ft. from the ground, and four days later I observed just below this point one small thin twig (only) about 2ft. long, the leaves on which had withered. This would correspond to a point about 18in. above the man's head. The following articles were found on the deceased: money—besides the silver—in left-hand breast coat pocket, inside, thirty-seven sovereigns and twenty-eight half-sovereigns in a common leather jaw-opening purse which had a metal rim and closed by two small knobs. The coins (nearly all) were wrapped in separate pieces of thin paper and the purse tied up in a handkerchief, In the waistcoat pocket, on the right side, a silver match-box containing two unignited wax matches and silver Geneva watch (no chain) were found. There was also a gold ring on one of the fingers. A pocket knife was also found. With regard to the condition of the coins, two half-sovereigns were slightly fused and adhering together; one sovereign was partially fused on one side as though a splash of metal had been thrown on it. Many more of the gold coins showed traces of fusion of the milling of the edges only; several of the silver coins also showed similar fusion of the edges The watch (open-faced) had a hole ¼in in diameter through the outer case by the hinge, and on opening this there was a splash of metal on the rim of the dome, and another on the bow. The watch had stopped at 6.55, but could be wound up. The steel hair-spring would not recoil, as probably it had lost its temper. The watch glass was broken. The ring and knife showed nothing. The metal rim of the purse had a small point of fusion on one side—inside – and the purse also had a hole through one side of the leather.

It would be interesting to know whether the base of the skull was fractured, as fluid was seen issuing from the left ear and not from the right one; whether from the apparent direction of the electric fluid in the line of the left pneumogastric nerve this would sooner affect the heart's stoppage; and, also, whether the deceased received the whole of the discharge or whether any passed over the woman's head to the pointed railings. There can be but little doubt that the gold attracted the lightning. Had deceased not been immediately under the tree his head would probably not have been struck first, but the gold would have received the discharge direct. The path of the lightning also should be noted—from the largest burn on the *left* chest (close to the heart's apex) through the watch pocket to the gold, thence to the *right* trousers pocket, touching the watch on its way, and giving a slight radiation towards the match-box. A violent explosive force was expended in the right trousers pocket so as to blow it to pieces and throw the silver coins towards and under the railings, where most of them were picked up at the time of removing the body. The next greatest force was expended in the right boot so as to blow away the adjacent inner sides of both boots. I gave evidence at the inquest, but the coroner would not give me leave to make a post-mortem examination, which no doubt would have added still more to what has been to me a case of great interest.—*The Lancet.*

TELEGRAPH LEARNERS' INSTRUMENTS.

The postal telegraph authorities and the railway companies all over the country are constantly requiring recruits for the manipulation of telegraph instruments. To become a telegraph operator one need know nothing of electricity, though of course such knowledge is not to be despised. To work the Morse instrument it is necessary to be able to manipulate the "tapper key" with facility and speed, tapping out the dots and dashes which constitute the symbols representing letters and words. Another class of instrument is the single-needle telegraph, Fig. 2, in which the depression of the right or left pedal moves the needle to one side or the other: a movement of

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the needle to the left or right corresponding respectively with the dot and the dash of the Morse instrument. To attain speed and certainty in signalling requires a great deal of practice, and the necessity arises for instruments whereon one can acquire this facility at home.

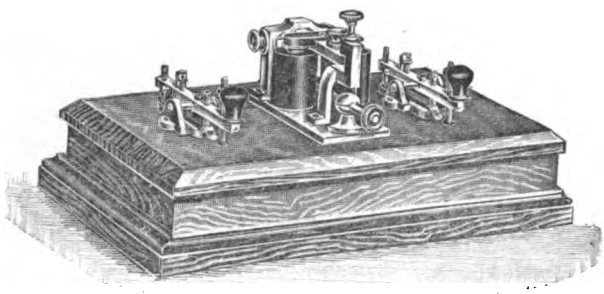

FIG. 1.

The instruments of Mr. Morris, of King's Lynn, fulfil the requirements of learners in a very effective manner. The instruments correspond outwardly in every respect with the actual apparatus as used by the Postal Telegraphs; but they are dummies so far as electrical action is concerned, the working being purely mechanical. The keys of the Morse instrument (Fig. 1) are connected with the armature of the sounder, and the pedals of the single-needle instrument with the needles, by very ingenious and simple arrangements of levers. The Morse instrument shown in Fig. 1 enables two persons to practise at the same time on the same sounder, one signalling to the other and *vice versâ*. For the same purpose the single-needle instrument (Fig. 2) has another dial and pair of pedals at the back. A simpler form of Morse instrument is provided with one key only.

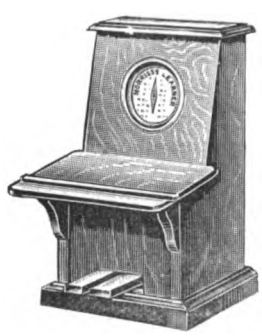

FIG. 2.

The doing away with all electrical fitting, and the absence of batteries, enables these instruments to be turned out at low prices, which are insignificant when compared with their educational value to the aspiring telegraph operator.

W. PERREN MAYCOCK, M.I.E.E.

[If we recollect rightly, some 15 years ago or so Mr. Volk, of Brighton, put upon the market, not dummy instruments, but workable needle instruments, eminently suitable for telegraphic learners. We could never understand why the sale of these instruments, or, rather, the production of these instruments, was dropped. The sale, we believe, was very good. Probably Mr. Volk sold them at too cheap a rate, and found work in other directions paid better.—ED. *E. E.*] .

PROBABLE PROJECTION LIGHTNING FLASHES.*

BY ERIC STUART BRUCE, M.A. (OXON), FELLOW OF THE ROYAL METEOROLOGICAL SOCIETY.

The revelations of the self-taken photographs of lightning flashes have of recent years caused us to modify our ideas concerning the appearance of lightning, and the varied forms displayed foretell that a future classification will be no easy task. The object of the present paper is to suggest the possibility of a kind of flash which may be called a projection flash, the existence of which species would by no means tend to make the work of classifying simpler.

When we view the effects of a distant thunderstorm over a large area such as the surface of the sea, sometimes a bank of clouds, sometimes the whole horizon, appears lit up with a sheet of light. This species of lightning we call sheet lightning, and we may compare this effect to my flashing this incandescent electric lamp, so that its flashes are reflected by this white screen. Though on the reflecting surface of clouds we can see no form of flash, yet we know that the sheet of light is made up of countless images of the lightning flash superimposed one upon the other so that we cannot distinguish them. So also when we flash this incandescant lamp we know that the light reflected from the screen is made up of a number of images of the white-hot carbon filament of the incandescent electric lamp. This is seen to be the case when I limit the space through which the rays of light pass from the incandescent carbon to a small orifice in an otherwise opaque screen. Then there appears an inverted image of a white-hot horseshoe of carbon on the screen—we call it the *projection* of the image of the incandescent carbon filament.

It seems obvious that in nature there must often be an obstruction between the lightning flash and the reflecting clouds, in the form of a cloud that has a small opening in it. This condition of cloud perforation is frequently seen. On the screen I throw a rough sketch of a cloud with four perforations, as seen from my balcony on Campden-hill, June 14, 1893. When there is a cloud with a sufficiently small opening in it, between the flash and reflecting clouds, the latter being in an adequate position, on the clouds which otherwise would have been merely illuminated by sheet lightning there will appear the optical projection of a lightning flash.

When the projection of an incandescent lamp falls upon a level surface, we obtain a perfect image of the white-hot filament. When, however, I cause the screen to become suddenly irregular, we obtain a distorted image of the filament on the uneven surface. And so in nature, if the surface of clouds upon which the projection of the lightning flash falls is quite even, we shall have a perfect reproduction of the lightning flash, save that it is inverted and to some extent dulled in brilliancy. If, however, as would often be the case, the surface of the clouds is irregular, the projection of the flash will take the shape of the irregular surface, and there will be presented a flash very different from the original.

On the screen I show a photograph of that type of flash which is called "streaming" in the report of the Thunderstorm Committee of the Royal Meteorological Society, drawn up by Mr. Abercromby (*Quarterly Journal*, July, 1888). To quote Mr. Abercromby's words, "it is a plain, broad, rather smooth streak of light." I will now project this flash on some model clouds of the cumulus type, and you see its appearance is altered, being no longer the smooth streak of light, but what might be called a zigzag flash with long angles. It is something rather like what has been often represented by painters in pictures where lightning appears, which leads one to think they may sometimes have taken projection flashes as their models perhaps because this form of flash would not dazzle the eye as does the real discharge.

It must, however, be borne in mind that Turner, in his storms, painted lightning flashes very like those registered on the photographic plate. In this print of Turner's "Bass Rock," the lightning flash closely resembles some of the photographs. It should also be mentioned that Mr. Ruskin, in "Modern Painters," when criticising Turner's "Stonehenge," describes the lightning in that picture as "the white lightning, not as it is drawn by less observant or less capable painters in zigzag fortifications, but in its own dreadful irregularities of streaming fire."

When travelling in Switzerland about three years ago, the train was passing through a valley while there was a severe thunderstorm in progress. The valley was filled with wreaths of mist, forming an uneven surface; suddenly there appeared in the midst a very zigzagged flash of lightning, seemingly quite close to the window of my carriage. It was not of that overwhelming brilliancy that would have been expected of it if it had been the electric discharge itself at such very near quarters, but was dulled so that I could see the form without my eyes being in the least dazzled, and I felt very inclined to think this was a projection flash.

* Paper read at the meeting of the British Association at Ipswich.

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If projection lightning flashes occur in nature as often as I am led to think is the case, it becomes a question whether the photographic plate can register the projection flash. If it does, we may be somewhat misled in our description of the form of the lightning flashes depicted on the plate, some being perhaps, not the original, but its distortion.

There is one more point concerning the projection flash which seems worthy of notice. If there are more openings than one in the cloud through which the rays of light pass from the flash, there will necessarily be a reduplication of the flashes giving a multiple effect. To represent a lightning flash, I now have a piece of platinum wire made white hot by the electric current. Between this and the screen I place a sheet of cardboard. I now make one hole in the cardboard, and there is one image of the lightning flash on the screen. I make a second, and there is another image, and as I continue to perforate the cardboard I get a corresponding number of images—perhaps those multiple effects we so often see explained by there being several openings in the cloud between the flash and the receiving surface.

MEMORANDUM ON THE BRITISH ASSOCIATION SCREW GAUGE FOR SMALL SCREWS.*

BY R. E. CROMPTON, M.I.C.E., PRES.I.E.E.

As a result of the two reports presented by the committee appointed by the British Association to design a standard screw gauge for small screws, a large number of users, including H.M. Post Office, have adopted them. In 1890 the London Chamber of Commerce appointed a committee to forward the question of making the British Association screw gauge universal among electrical manufacturers, and a circular was sent round to the entire electrical manufacturing trade, with the result that with hardly any exceptions the whole trade promised to adopt the screws, and thus ensure the extremely desirable result of making all the small screws used in electrical apparatus interchangeable. It is, however, much to be regretted that a considerable number of users of small screws (the principal offenders having their works in Birmingham) are still using other gauges, and thus complete uniformity has not been obtained up to the present time. One great difficulty in this matter has been that of obtaining standard gauges which could be referred to in specifications or orders for such screws. Wherever it is desired that the screws should be thoroughly interchangeable it is necessary in such specifications to have a paragraph somewhat as follows:

Testing.—Each box of screws will be tested as follows: A handful of one dozen screws will be selected at random from each box; these will be tested both as to the screw portion and the plain portion of the shank by being respectively screwed or pressed through the corresponding maximum and minimum gauge holes in the standard plates supplied on loan with the order, and which must be returned with the finished screws. Any screw which cannot be screwed or pressed by hand into the maximum female gauge, or which can be screwed or pressed by hand without force into the minimum gauge, will be rejected. If more than one screw in each dozen thus tested is so rejected, the whole box will be returned to the contractors.

Four years ago I found it necessary to have standard plates made for the purpose of ordering screws to the above specification. I had a number of such plates prepared, but found the very greatest difficulty in getting them made so that they would fulfil their required duty, the makers giving as an excuse that there was no standard B.A. gauge then existing to which they could refer. This difficulty can only be removed by a complete set of standards being made and deposited either with the Board of Trade or at the Society of Arts, or with a similar central institution; and it is highly desirable that the British Association should either call together the surviving members of the original committee or form a new committee to consider the question of making up these standard gauges and deciding on the place where they are to be deposited.

One question for the committee would be the requisite allowance of clearance between the absolute diameters of the various sizes as laid down in the report of the committee and the sizes of the maximum and minimum gauge holes in the gauge plates. Another point of importance in order to make this standard screw gauge universal would be the issue of a short descriptive report, with illustrations, giving the sizes, clearances in gauge plates, best method of reproduction on English lathes of these screws, together with a few sectional drawings showing the shape of thread, rounding off, etc.

DO VERTICAL (EARTH-AIR) ELECTRICAL CURRENTS EXIST IN THE UNITED KINGDOM?*

BY A. W. RUCKER, F.R.S.

In a paper by Dr. Adolph Schmidt read before Section A of the British Association at Oxford, the author stated that he had expanded the components of the earth's magnetic force in series, and had deduced expressions, two of which give the magnetic potential on the surface of the earth in so far as it depends on (1) internal and (2) external forces. "The third series represents that part of the magnetic forces which cannot be expressed in terms of a potential, but must be due to electric currents traversing the earth's surface." The author concludes that such currents amount "on the average to about 0·1 ampere per square kilometre." It appeared, therefore, desirable that this conclusion, drawn from the magnetic state of the earth as a whole, should be tested by means of those portions which have been most fully studied.

The test to be applied is whether the line integral of the magnetic force taken round a re-entrant circuit is or is not a vanishing quantity. The irregular form of the United Kingdom makes the application of this test more difficult than it would otherwise be, but as two detailed surveys of Great Britain and Ireland have been carried out by Dr. Thorpe and myself for the epochs 1886 and 1891 respectively, the data at our disposal are so numerous that I thought it worth while to undertake the enquiry. The actual work of calculation has been carried out almost entirely by two of my students—Messrs. Kay and Whalley. My best thanks are due to them for the care and skill they have displayed. Two circuits, called the α and β circuits respectively, were selected, bounded by the following lines:

(α) Long. 2° W., Lat. 58° N.; Long. 7° W., Lat. 52° N.
(β) Long. 1° W., Lat. 55° N.; Long. 9° W., Lat. 52° N.

The work done by a unit magnetic pole on traversing these circuits was calculated for the epoch 1886·0 by means of the terrestrial lines found for that date, and also for the epoch 1891·0 by means (1) of the same lines when due allowance was made for the secular change, and (2) of the independent set of lines found by aid of the later survey. The magnitudes of the hypothetical currents deduced from these calculations were very small, and those for the later epoch were of opposite signs, according as they were calculated from the earlier or the later survey.

The same calculation was made for two other circuits, one (γ) in Great Britain and one (δ) in Ireland; but instead of using the calculated terrestrial lines, the true values of the forces and declinations were employed, as deduced from the nearest stations. The great local disturbances in Antrim interfered with the value of the Irish circuit. The following table gives the results in amperes per square kilometre obtained from circuits α and β by the terrestrial lines for 1886·0, and also by the mean terrestrial lines for 1891·0, which occupy the mean position between those given by the two independent surveys, and also for circuit (γ).

	Circuit.		
	α.	β.	γ.
1886·0	−0·026	−0·004	—
1891·0	+0·001	−0·005	—
1891·0	—	—	−0·008

From these we may conclude that there is not in the United Kingdom a vertical current amounting on the average to 0·1 ampere per square kilometre. There may possibly be a current of about a tenth or a twentieth of that amount, and, if so, the signs show that it probably flows from air to earth, but on account both of the smallness of the results and of the discrepancy between the values obtained for 1891 by two independent calculations, we cannot assert that such a current actually exists.

The calculations do not disprove Dr. Schmidt's hypothesis, as we cannot argue from the condition of a small portion of the earth's surface to that of the whole. The most that can be said is that no evidence in favour of the existence of vertical currents can be drawn from one district which has been very minutely surveyed.

* Abstract of paper read at the meeting of the British Association at Ipswich.

* Abstract of paper read at the meeting of the British Association at Ipswich.

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THE FIELD TELEGRAPH IN CHITRAL *

BY P. V. LUKE, DEPUTY DIRECTOR-GENERAL OF INDIAN TELEGRAPHS.

The field telegraph required for the army in India, for the many small expeditions in which it is so often engaged, is furnished by the civil telegraph department. The department must be ready, therefore, at all times to meet any demands made upon it. A suitable equipment has been designed and a stock is kept at convenient depôts at various points on the frontier; this enables an immediate start to be made with the construction of the field telegraph in any operations, while for prolonged operations the whole resource of the civil telegraph department can be made available. All the equipment is arranged for "pack" carriage; the maximum weight of any one package is fixed at 80lb. (one half the load a mule will carry). After every campaign a full report is sent in of the working, and any defects brought to light are dealt with at once. The receiving instrument used is a sounder similar to the one used throughout India, only reduced in size. It is fitted on a baseboard with a small Siemens relay and a key with connections so arranged that it can either be worked "direct" or as a "local" A perfect portable battery has still to be designed; at present the so-called "dry" pattern is used. The unit of office equipment or total needed for one field office which includes tents, etc., comprises seven mule loads, but it can be compressed to four loads if necessary for an emergency and for temporary work. Telephone apparatus is always included. The line wire employed is iron wire weighing 300lb. and 150lb. per mile and stranded hard copper wire weighing 80lb. per mile; light field cable is used for certain purposes. For poles, where possible, the resources of the country passed through are utilised, but for bare country iron poles are carried. They are tubular sheet iron in three pieces, fitting telescopically; the total height is 18ft., and weight 40lb., the packages being 5ft. long. At 20 to the mile they will carry three wires one in a cap, the other two on insulators. The rate of construction depends on the transport, labour, and character of country. In the Waziristan campaign a single wire line was put up at rate of nine miles a day for five consecutive days Special arrangements for rapid repair are always made; for this purpose it is necessary to have a telegraph office at every 10 miles with a trained line staff. For the signalling staff trained British soldiers are mainly used; these men are employed at other times at different telegraph offices throughout the country, usually where their regiments are quartered. The field telegraph forms a distinct department in the field, under a civilian telegraph officer appointed by the Director-General of Telegraphs, and taking his orders from the chief of the staff.

Information of the siege of Chitral came from Gilgit over the line which was only completed in 1894. This line is carried over two passes, one 11,600ft., the other 13 500ft. above sea level, where the snow lies from 10ft. to 18ft., yet it worked well all through the winter. The staff at the observation stations close to these passes are entirely cut off from the rest of the world except by wire for seven months in the year. The place selected as the base of operations was Holi Mardan. Best material for a two wire 200-mile line with 20 offices was at once collected, together with the necessary staff for constructing and working. From this point the wire was pushed on as fast as possible, and a field office was opened on the Walakand Pass a few hours after the battle At first it was a single-wire line, but it was afterwards made a three-wire line as far as the Swat Valley, then a two-wire to Dir, and finally one-wire to Chitral Fort. Great difficulties with transport occurred at Lowari Pass owing to the pass not being passable for camels; but for this the wire would have been into Chitral by May 12; as it was, it did not reach there till midnight of the 17th On account of the scarcity of timber it was necessary to use iron poles very extensively; at the Lowari Pass, however, there is a fine pine forest; wooden poles were afterwards used. After May, cutting the wood became very frequent and even very difficult to stop After the start the traffic, which was exceedingly heavy, was dealt with with but little delay. In April 24,370 and in May 58,935 messages were dealt with, and their length was much above the average Shortly after the Malakand fight by clearing the line right through to Simla the Commander-in-Chief was enabled to talk direct to General Low, and in spite of heavy rains at the time the communication was excellent To give some notion of what was accomplished it may be stated that a telegram dated Chitral Fort, May 19, was published in the London papers of the same date.

The telegraph department also assists in defending camps by running wires round the camp, so arranged that an alarm is at once given by the ringing of a bell in the quarter guard should a night surprise be attempted, and in many other ways much aids and assists the military authorities. Medals and decorations are given to the staff at the conclusion of the campaign.

* Abstract of paper read at the meeting of the British Association at Ipswich.

THE CORPORATION OF CORK.

The following is the report of the Electric Lighting Committee to the Council:

Reference from Council, July 5, 1895.—To consider and report on the following—viz.: Notice from Hanrahan and Co., solicitors for the Cork Gas Consumers' Company, of their intention to apply to the Board of Trade for a provisional order to authorise them to supply electric energy within the city of Cork, under the Electric Lighting Acts, 1882 and 1888, and requesting that a meeting of the Corporation may be convened to consider the matter. Like notice from R. A Atkins, Esq, J.P., on behalf of the Cork Electric Light and Power Company, Limited; and like notice from Edward Felton, of 35, Careysfort-avenue, Blackrock, co Dublin, on behalf of a company to be formed and known as the Electricity Supply Corporation of Ireland, Limited.

Your committee at their first meeting having resolved that in their opinion the time had come when electricity for public and private purposes should be provided in the city, whether by the Corporation or some other body duly authorised, considered it necessary, before proceeding to the consideration of the subject of reference, to ascertain from Dublin and other municipalities how far the local corporate bodies had undertaken the work of electricity supply, and with what results as to the public service and the advantage of private consumers, and more especially with regard to the financial results of such undertakings. Queries were accordingly addressed by the secretary of committees to some 50 local authorities throughout the United Kingdom, and the information so collected was embodied in a report which has already been printed and circulated amongst the members of Council

That the demand for electrical energy, whether for lighting or motive power, is everywhere increasing is amply demonstrated by that report, and private enterprise has already to some extent been called upon to satisfy the demand in this city. The order of reference to the committee shows that there are capitalists quite ready to embark in undertakings of this kind, even in Cork; but the first question to be considered in your committee's opinion is, whether the duty of supplying a public necessity of this nature should be allowed to fall into the hands of any but the municipal authority. The prevailing opinion throughout the kingdom appears to be that the control of electricity supply ought, like that of gas and water, to devolve upon the local governing body, and your committee feel disposed to adopt that view. The superiority of electric light over the other common illuminants is generally conceded; but the consideration which will probably weigh most with a body of the limited resources of the Corporation of Cork is, how far the benefits derived from its adoption would warrant the increased expenditure that would have to be faced In the other municipalities referred to, the experience of the local authorities has been somewhat diverse in this matter of financial results, owing, doubtless, to varying local conditions.

In most cases a pecuniary sacrifice has had to be made in the first year or two where the local authority had undertaken electricity supply for all purposes, but as the demand grows and capital expenditure diminishes the direct results become more satisfactory. In some places, favourably circumstanced and with good administration, an immediate financial benefit has accrued to the ratepayers but these cases are the exception. In the instance nearest home that of the Dublin Corporation, which now lights the principal public thoroughfares with electricity, besides supplying current also for private purposes, the financial results are summarised by the city accountant in one sentence, when he states that "the first year's revenue, if viewed in the light of an undertaking by a private company, would yield 4½ per cent on the capital invested." There are, however, indirect benefits which the introduction of electrical supply has secured in many places, such as the reduction in the price and the improvement in the quality of the gas supplied to the public, and it is at the same time noted as an almost universal experience that the consumption of gas has in those places increased rather than diminished

How far the administration of a new department of this kind, in the corporate service of this city, would be a success, is a question well worthy of consideration; but it has been suggested that, even if the Corporation were to delegate the work of electricity supply to a private company, under proper safeguards and conditions, the authority to provide the supply should primarily rest with the Corporation. Before, however, arriving at any definite conclusion, or making any specific recommendation on the subject, your committee find it necessary to obtain competent professional advice as to how far the area of advice ought to extend, what the reasonable probabilities might be as to expenditure and income in connection with such an undertaking, and other subsidiary considerations which ought to influence the Corporation in dealing with a project of such novelty and importance to them. In order, therefore, to be in a position to avail of such advantages as legislation has placed within your reach, should you so determine, and to be enabled to do so fortified with adequate scientific knowledge and practical experience, your committee for the present content themselves with recommending that the town clerk be instructed to convene a special meeting of Council for Friday, October 27 proximo [?], for the purpose of taking into consideration the notices already received from private companies of their intention to apply to the Board of Trade for provisional orders, and also to consider the expediency of the Corporation themselves applying for a provisional order authorising them to supply electrical energy within the district; and that for the purpose of enabling this committee to form a definite opinion on the latter subject, and to advise the Council as to what course they ought to adopt in the premises, the committee be authorised to employ a competent electrical engineer, of sufficient practical experience, to assist them in considering the whole subject and reporting thereon. All which your committee submit as their report, this 18th day of September, 1895.

JAMES L. BOGAN, Vice-Chairman.
D. F. GILTINAN, Secretary of Committees.

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SOME LESSONS IN TELEPHONY.*

BY A. R. BENNETT, M.I.E.E.

(Concluded from page 321.)

On enquiring in what manner circumstances differ so gravely in the United Kingdom as to preclude the possibility of small towns and rural communities availing themselves of telephonic communication, it appears that, apart from the want of local control and competition, the inelasticity of the present system of tariffs, which was originally invented for towns, is much to blame. In towns distances are short, and subscribers, if the switchrooms are properly distributed, have seldom to pay more than the unit charge, but in country districts distances of several miles must often intervene between the subscriber and switchroom, and as the annual rental exacted increases rapidly with the distance the charges become piled up by the extra mileage beyond the means of the majority of the population. What is wanted is the application of the Austrian (which with some modifications has also been adopted in Luxemburg) system of tariffs, under which all subscribers, whatever their distance may be from the switchroom, are put on an equality as regards annual subscriptions, the only difference being made in the initial payment on joining the exchange, which varies with the length of line required, the object being to reimburse the owners of the exchange system once for all for the additional cost of the extra mileage. In Austria the annual subscription is the same for any distance up to 15 kilometres (9¼ miles). In Luxemburg the annual subscription, provided the distance of the subscriber from an existing route of wires is not greater than 1½ kilometres—which is seldom the case, so numerous are the lines—is always £3. 4s. per annum, which covers all charges for service and maintenance, and confers the right to talk all over the Grand Duchy, which measures 44 by 30 miles. If a subscriber is situated outside the free radius which surrounds every switchroom, he makes, on joining the exchange, an initial payment, designed to cover the cost of the line which intervenes between the free radius and his place. This is charged at the rate of £4 per kilometre only, and the payment may furthermore, if desired, be spread over five years. If located within the free radius, the subscription is simply £3. 4s. per annum without an initial payment. Comparisons are often instructive, and it will be interesting to examine the differences resulting from the application of this system and that which prevails at home.

In Luxemburg a subscriber located five miles (eight kilometres) from the boundary of a telephone area (provided he is not more than 1½ kilometres from an existing line) will pay :

A compensation for extra distance, £5 × £4 = £20 in one payment, or, if he chooses, divided into five annual payments of £4, and thereafter an annual subscription of £3. 4s. If 15 kilometres (9¼ miles) away he pays £15 × £4 = £60 down, or £12 for five successive years at his option, together with an annual subscription of £3. 4s. He may be taken to pay £15. 4s. for the first five years, and £3. 4s. per annum for all time thereafter. The British Post Office charge £14 per annum per mile, so that a subscriber five miles from a switchroom would be charged £70 per annum in perpetuity, while one 9¼ miles away would pay no less than £134 per annum. The National Telephone Company's charges would be more than this in the metropolitan area and less in the provinces, but always, as experience has amply proved, prohibitive.

The different results aimed at in the United Kingdom and in Luxemburg need, therefore, create no surprise. They are simply examples of cause and effect. It cannot be said that such rates as are applied in Luxemburg do not pay. Accounts and balance-sheets have recently been published† which prove that even lower charges are made remunerative by local companies and municipalities in Holland, Denmark, and Norway.

The telephonic development attained in the Aland Islands, the entire population of which numbers but 18,000, has been mentioned. What have we to show at home of a corresponding nature? The Isle of Man (population 55,608) has one exchange. The Isle of Wight (permanent population 78,672, which is much increased in summer), containing seven or eight flourishing towns, possesses no telephonic facilities whatsoever ; and the Channel Islands (population 92,234) are in equally bad case, although both Jersey and Guernsey are places in which a good telephone system would be of the utmost value, owing to the necessity the farmers are under, especially at certain seasons, of maintaining good communication with the ports, St. Helier's and St. Peter's. Exchanges in these towns alone would be next to useless : it is necessary to bring the outlying villages and scattered farmsteads into connection with them, and as this would necessitate many lines of from two to five miles in length, the existing tariff both of the Post Office and National Telephone Company are prohibitive and impracticable in a ludicrous degree. But an intelligent application of one or other of the Norwegian, Finnish, or Luxemburg methods would speedily cover the islands with telephone lines, and that with profit both to the servers and the served. The cases of Jersey and Guernsey have, unfortunately, their parallel in most of the country districts in the three divisions of the United Kingdom.

One of the Norwegian companies—the Drammens Uplands—affords a striking example of profitable rural telephony. The area for which it holds a concession from the Government extends over five counties and measures 143 miles from north to south, the most important places served being the villages called Kongsberg and Hönefros. At the end of 1894 the company possessed 24 switchrooms, 292 subscribers, 478 miles of poles, 1,553 miles of lines, including 671 miles of metallic circuits. Its annual subscription, which covers a line not exceeding two kilometres in length, and the right of free conversation over the whole of the five counties, is only £5. 11s. 1d. Its capital account stood at £9,815 ; its receipts from all sources for the year amounted to £2,332 ; the net profit was £752 and the dividend 6 per cent. This dividend has been paid regularly during the five years of the company's existence, and a deterioration and reserve fund built up besides. These are facts which should surely plead against the present era of telephonic stagnation.

The technical features of the continental systems are, as a rule, best where the tariffs are lowest and the extension of communication greatest. The conditions laid down by the author in his paper on "The Telephoning of Great Cities," read at the Cardiff meeting of the British Association in 1891, as being necessary to a well-ordered exchange, are fulfilled more nearly in Sweden than elsewhere, especially by the General Telephone Company, which operates in Stockholm and a radius of 43½ miles around. Metallic circuits are universal ; special attention is given to prompt switching, and Stockholm is divided into eight nearly equal divisions each containing a switchroom. The prompt and economical addition of new subscribers is thus rendered easy. The speed achieved in switching is that stated in the paper to be practicable and proper in a good exchange—viz., 10 seconds. The countries comprising Groups II. and III. are, with some exceptions, technically behind those of Group I. The reason lies on the surface. The conditions which prevail in Group I. bring about rapid extension ; rapid extension involves the solution of problems which do not present themselves while exchanges are in their infancy, and the solution of such problems evolve superior engineers.

* Paper read at the meeting of the British Association at Ipswich.

† "The Telephone Systems of the Continent of Europe." Longmans, Green, and Co., London and New York.

THE DEVELOPMENT OF THE TELEPHONE SERVICE IN AGRICULTURAL DISTRICTS.*

BY MAJOR-GENERAL WEBBER, C.B, R.E., M.I.C.E.

On April 20, 1895, the *Times* published a letter on my subject which I had written to them as follows :

"The Telephone in Rural Districts.

"Sir,—May I occupy a few lines of your space in attempting to show that the telephone as well as the light railway may (in the words of the Queen's Speech) be 'found beneficial to the rural districts.' In many countries the telegraph (including the telephone), which is the handmaid of railways, has been their pioneer, often because the capital outlay required for its establishment is comparatively small. As the future fate of the telephone service of this country is at the present hanging in the balance, it seems an opportune moment to draw attention to the question from the point of view of the 'continued seriously depressed condition of agriculture.' The county is the unit of area with which I have studied the subject, and the district round each market town is the natural site of an exchange system, with inter-communication between market and county towns. Some of the advantages of a complete telephone service to the dwellers in the rural districts of a county through the establishment of a call-office in nearly every parish can be easily realised : to the farmers, the being able to converse with salesmen and customers at the market towns, saving journeys, and avoidable movement of stock and produce ; to the village tradespeople, the facility of promptly replenishing small stocks ; to the inhabitants, the power to converse with the shopkeepers in the market towns for their larger purchases, thus keeping trade within the locality ; to the dealers in perishable articles, such as milk and fruit, the value of the advantage is not easy to compute. The distribution of labour and material to meet demand would be better guided and expedited than existing means of communication admit of. Fire-engines and ambulance aid could be promptly summoned to places however remote ; and, lastly, the administration of the executive duties of the county council would be enormously helped. I have worked out a scheme for such a rural telephone service in one of the purely agricultural counties, which has nearly 400,000

* Paper read at the meeting of the British Association at Ipswich.

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inhabitants and a gross rental of nearly two millions, and the figures present a very hopeful result. The material used would be what military telegraphers would call 'light permanent line,' and of the character largely used in Europe for the telephone. Such a county would require 29 exchanges, and call stations at 415 villages and hamlets. The length of pole line required to be erected would be a little over 1,000 miles, and the length of wire to be run a little over 4,000 miles. These figures are exclusive of the lines from private premises to the exchanges, which might in time be reasonably expected to number 700 or 800. The capital outlay would be about £49,000, and the annual cost, including interest, sinking fund, maintenance, renewal, working, and management, would be about £12,000 per annum. These figures are based on cost price, as if the work was undertaken by the county council. To cover this a charge of 2d. would be made for each conversation of five minutes within arranged areas, and this must amount to a daily average of takings at each call-office of 1s. 11d. The value of the service to the county administration and the net result of the revenue from the private lines would be profit. How far such a scheme would fit into the existing postal-telegraph system, or interfere with or help it, is more a question for the Parliamentary Committee, now sitting on the subject than for your pages. Without any delegation from them I venture to advocate the cause of the local authorities in the 120 counties in the United Kingdom.—I remain, Sir, your obedient servant,

"C. E. WEBBER."

On May 14, 1895, I was examined before the committee of the House of Commons on the subject, and gave some details of the proposals contained in that letter. It has occurred to me that as the suggestion if carried out throughout the United Kingdom, whether by the Post Office or by local authorities, would involve a very large expenditure, that, from the engineering point of view, this section is an arena not unsuited to its discussion. I have therefore entirely revised the figures in detail, and prepared the map of the county of Suffolk which is exhibited. Neither the National Telephone Company (the monopolists for 15 years of the telephone in this country) nor the Post Office would ever dream of adopting such a development of the service as that which I have suggested. I therefore do not expect to receive support from either of those bodies from the revenue and commercial point of view.

As a natural consequence of the meeting of the British Association this year being held at Ipswich, I have selected the county of Suffolk as the most suitable area for an example of the proposed work. The map of the whole county before you is on the 1in. scale; and it will be seen that every sub-post office is marked on it with a blue disc, and that each office which is also at present a telegraph office is marked, in addition, with a flag. The places at which under my proposals a telephone exchange office would be established are distinguished by a red circle outside the blue. At present the main telegraph lines throughout the county are, with one exception, placed on the railways—that exception being the road line from London to Lowestoft, which was erected on the main road which lies throughout its length contiguous to the main line of railway of the Great Eastern Railway Company. This line I had the honour to lay out and construct in 1870, being then divisional engineer of the postal telegraphs in this part of England. The other telegraph lines in the county are almost exclusively short branches from the railways to the post offices at the large and small market towns, numbering altogether 105.

The number of places at which under my proposals it is intended to establish telephone call offices in addition to those where telegraph offices exist is 246. This makes a total of 351 places in the county of Suffolk where telephone communication could be had by the public. The places, included in the above 351, at which exchanges with public connections would be established are: Lowestoft, Beccles, Bungay, Halesworth, Southwold, Saxmundham, Aldeburgh, Wickham Market, Framlingham, Woodbridge, Felixstowe, Eye, Debenham, Batesdale, Haughley, Stowmarket, Needham Market, Thetford, Brandon, Mildenhall, Bury St. Edmunds, Newmarket, Haverhill, Clare, Long Melford, Sudbury, Hadleigh, Nayland, Ipswich; 29 exchanges in all.

These exchange systems will require the construction of 524 miles of new line along roads not already occupied with lines by the Post Office, coloured green on the map. They will also require wayleave for wires on 253 miles of existing telegraph lines along roads already occupied by the Post Office, coloured blue on the map. In addition, it is proposed to obtain wayleaves on 37 miles of existing poles on the railways, coloured red on the map. Giving a total of 794 miles of lines to form the systems. For obvious reasons it is proposed to have only one wire with earth returns for each circuit; but it is also proposed, where interchange between exchanges is required, and in special cases to prevent the effects of induction, that such shall be effected by means of twin wires. On the map the lines alone are shown by a single line of the green, blue, and red, as the scale will not allow of the individual wires being distinguished.

It is not suggested here as a necessity that the existing Post Office poles should be used. A new pole line could be erected along the same road, but it is obvious that where there is space to carry additional wires it could be made mutually advantageous to use them. For this user the county telephone system would pay an annual wayleave at the rate of 10s. a mile of conductor, single or twin. The number of wires, including trunks, for which space will be required on a pole, whether it is an existing one, or one especially erected, varies from one to eight. The average will be five. This will require a total mileage of 3,970 new wire. In the construction a much lighter material can be used than that to which we are accustomed by Post Office use. The poles, which will be of a size to be procured largely in the district, may or may not be creosoted. Their cost will average in either case £12. 10s. a mile, and £20 a mile when erected complete with brackets, insulators, struts, and stays. In some out-of-the-way districts the Post Office allow themselves to limit the poles to 17 to 18 to the mile, but I should provide 22 to 25. The insulators would be small single shed, as used in France and Switzerland, having a bent shank to screw into the timber. They may be fixed within 9in. of one another, measuring vertically on the pole. The conductors would be of No. 18 bronze, and costing £5 per mile when "run." In case the Post Office should demur to the call-boxes being placed in sub-offices, there is little doubt that small shopkeepers would be found willing to provide the call office and take charge of it, with a payment of, say, 2s. 6d. a week and a percentage of the receipts after they have reached a minimum, say, of 2s. a day, added to which would be the advantage of attending the circuits of private subscribers. No skilled labour is required, and the necessary attention and attendance could be given by the youngest girls of a family. On the Continent of Europe, the village schools arrange that boys and girls shall have leave of absence in turn for such duties. When we come to our senses on the subject of withdrawing country children from rural occupations to sit all day in a school, the same thing would be done in Suffolk.

The cost of the system for Suffolk may be estimated as follows:

29 exchanges at an average of £151 (This provides for 50 per cent. spare connections.)	£4,375
351 call stations, at an average of £7 10s.	2,633
524 miles of new lines, at £20 per mile	10,480
3,970 miles of wire run on new and existing poles, at £5 per mile, with double conductors in the case of 950 miles	23,820
Add 1-10th for contingencies	4,130
Total capital cost of the system	£45,435

The receipts or takings of all kinds will have to provide for the following annual expenditure and allowances, so that if the system were established by the County Council there should be no charge on the rates:

Interest and sinking fund on £45,500 at 4½ per cent.		£1,933
Renewal fund—Of poles at 7 per cent.	£733	
Of wire and instruments, at 3 per cent.	238	
		971
Private wayleaves (estimated)		524
Wayleaves on existing poles, for each double or single conductor at 10s. a mile		675
Management		300
Maintenance—salaries and wages: one inspector	£200	
One assistant inspector	150	
Four linemen	280	
Small stores and sundries	250	
		880
351 call offices, rent, attendance, including small stores and sundries, average £9		3,159
29 exchanges—Salaries	£80	
Rent	12	
Small stores and sundries	10	
	£102	= 2,958
Add 5 per cent. for contingencies		573
Total annually		£11,973

Say £12,000 a year.

The greatest portion of the above payment for wayleave on existing poles would be a clear gain to the Post Office revenue. The cost of private wayleaves might be much less than the amount estimated, if the lines are the property of the County Council. The value of the service to the administration of the county I place at £350 per annum. It will thus be seen, after also deducting £900 for profit on private lines, the most that must be earned is £10,660 per annum. That individual occupiers of all ranks would be found ready and willing to pay for the convenience is highly probable, but its application would be limited, owing to the great facilities proposed to be afforded at the public call offices.

One of the chief inducements to the possession of a private line to one of these exchanges would be the facility given for communication with the postal telegraph system of telephone lines. Naturally a Post Office license for such a telephone

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system in the county of Suffolk would include the obligation to connect up with all the postal telegraph offices in the county. In most cases it may therefore be held that the subscriber will wish for a service necessitating two wires. Estimating the average distance of a subscriber's house from the exchange at 2½ miles and that 1½ miles of this will be on special poles, and that each will require a twin-wire conductor, the outlay on each private subscriber's line would be on an average £71. With this outlay a profit of £3 out of an £8 annual subscription is not an over-estimate, the outgoings including a special extra payment at the exchange for services for each such private subscriber, which would be an increment to the wages of the call-office attendant. It is not too much to expect that three or four hundred private subscribers in one large county like Suffolk may be expected in time, whose subscriptions would yield a net revenue of £900 to £1,200 per annum.

The next aspect of the question from the County Council point of view is the value of the assistance given to the conduct of county business. I have consulted several chief constables, and they are all unanimous in testifying to the great help such means of communicating about the county would afford to their department both as regards efficiency and economy. The same remarks apply to the departments of sanitation works, health, and education. No small facilities would be given to all operations affecting the exercise of the suffrage at elections for all purposes. The various district and parish councils would be more in touch with one another and with the supreme county authority. To all this service I have attached the exceedingly low valuation of £350 per annum. As regards trade, it is not too much to say that saving of time is the essence of the acquisition of profits, and, that, if this can be achieved at a very small cost in proportion to the service rendered, an infinity of processes in the smaller industries and trades can be helped, on a scale which the telegraph and telephone—the most important means of saving time—have never yet attempted. Light railways—with which I have dealt in another paper read before this section—may or may not be financially possible to take the place of the present means of transport in agricultural districts: they are a substitute for something already in use; but such a system of telephony as I have described is an entirely new development of a means which may prove a first necessity of the daily business life of the small cultivator and village tradesman, as it must evidently be in that of the farmer.

I submit the following for consideration, as indicating the uses to which the telephone may be put in rural districts: The being able to converse with salesmen and others at the market towns would save journeys and premature movements of horses, beasts, and produce. The power of speaking with another farmer or bailiff at another farm, in another village, on questions of exchange of produce, labour, transpost; also as to meteorological conditions. The village tradesman would have increased facilities for meeting wants that otherwise require a journey of himself or of his customer. Purchases in the market town from the superior tradesman could be made by conversation, and perhaps the expenditure of money be kept within the locality, instead of sending to London or the large towns for small articles of consumption. All that appertains to the service of stallions and bulls would be more simply settled by conversation than by letter. Questions regulating the accumulation and transport of perishable food material, such as milk, would be assisted, and time and occasional confusion and loss would be saved. Farm labour, male and female, would have opportunities of information as to demand and supply, and market-town hirings would be diminished. Besides this, social gatherings amongst all classes, to the advantage of out-of-the-way districts, would be promoted, indirectly checking the migration of the rural population to the towns, and the operation of lending libraries would be assisted. Naturally, the question of the early arrival of medical aid and ambulance assistance, and in case of fires, occurs to anyone who considers the subject.

Now, as to the charge to be made for each use of a call office, the audience may be surprised to hear that I propose to put this at 2d. for three minutes to cover the use of one exchange, with a small addition, say, of 1d., if it is necessary to communicate through two or more exchanges within the county. The rates external to the county would be governed by those over the postal telephone trunk lines. It is only necessary for the gross takings at the 351 call offices to be on an average of 2s. per diem for 309 days in the year in order to cover the £10,660 outgoings already calculated above. I should be inclined to keep the system open for 16 hours out of 24, but that is a detail, and may vary according to local circumstances. Of course, by previous arrangement for official purposes it could be kept open continuously at a correspondingly increased cost for attendance. If the takings average 2s., I should propose appropriating a part of them to a fund to be used as premiums for good service of the employés. For the messenger service required to summon a correspondent and bring him to the call office a special charge per quarter of a mile would be made, and need not exceed one penny to be paid at the time by the person called. It is not to be expected that the Post Office could look on with perfect equanimity at the realisation of such a scheme as this, because they will at once apprehend a lessening of revenue at their 105 county of Suffolk telegraph offices. I have no information as to the number of forwarded and received messages at those offices, but it would be interesting if the Post Office will give these figures for the year since the adoption of the sixpenny rates, both as regards what might be called local and external traffic. I think it is highly probable that the quantity of local messages only would be affected, and that there would be a compensating increase of external telegraph messages. Besides, as the local telephone exchanges would be in communication with the telegraph system, there would doubtless arise a very considerable correspondence by telephone over the Post Office trunk wires, which would be a new and hitherto untapped source of revenue. There is also a compensation in the wayleave rental of £675 a year, payable to the Post Office, to which I have already referred. I would observe that Post Office objections, if any were made, on account of loss of revenue through a decrease of correspondence between, say, one county and another, or between the county towns and the Metropolis, should such arise, might lead to letting light in on a question which I believe has not been sufficiently considered—namely, whether the wide extension of telegraphic and postal facilities in the last 25 years may not be one of the indirect causes of what is called agricultural depression. For while these particular facilities have been increased, those for the economical conveyance of persons and goods have shown no corresponding advance. By this, what might be called the due balance of means for advancement of local trade has not been secured, and it may very possibly be shown that through such an apparently trifling absence of adjustment, the great diversion of trade for the supply of London from the country districts of England to the Continent has been assisted.

I do not think we need sympathise with the departmental objections of the Post Office to the loss of revenue on what might be called the "private wire branch." Ever since the transfer of the telegraphs to the Government the charges for such service have been practically prohibitive. Some idea of the exorbitance of these rates is given by the fact that, if such a system as I have described was established in Suffolk by the Post Office and rented to the County Council to work for the use of the inhabitants, the rent alone for the lines and stations, at the Post Office published rates, would be at least £18,658 a year for what in my estimate costs £5,388 a year, and each private subscriber would have to pay on an average about £20 a year. As regards what the National Telephone Company have done in Suffolk up till now I can obtain no information, although I have applied for the information to the company.

I hope that it will be realised that what I have described is entirely practical and feasible. I have not allowed in my estimates for a contractor's as well as an engineering profit, but the funds I have detailed for are amply sufficient. Also that if undertaken by the local governing bodies great benefit would arise without any charge on the ratepayers. It is hard to believe that the system would not become very popular in the use, and in the interim, say for the first three or four years, the Post Office might well forego any royalty, seeing that the late and present Governments have expressed such warm sympathy with the conditions of the greatest industry in the land. As I have suggested, it seems reasonable to believe that the facility afforded of being able to converse between county neighbourhoods, and between them and urban and suburban districts, will do much to check migration to the large thickly-populated centres. If you annihilate distance for purposes of conversation, may you not do away with many an excuse for accusing country districts of being "too dull to live in?"

Joint Discussion on General Webber and Mr. Bennett's Papers.

The Chairman (Prof. L. E Vernon-Harcourt), in proposing a vote of thanks to the authors, said that General Webber's proposals struck him as rather Utopian.

Prof. Silvanus Thompson said that, after listening to the papers just read, they could not but be impressed by the backwardness of the United Kingdom in the important matter of telephonic communication. The contrast that had been drawn between the Grand Duchy of Luxemburg and the county of Dorset was not flattering to our national pride, and Suffolk, judging from the figures cited by General Webber, did not appear to be much better off than Dorset. The time had come for the Government to make an earnest effort to give the telephone freer play. One select committee had met and proved abortive, and another was mooted, and this he hoped would meet soon and come to an early decision The Government had three courses open: (1) to take the whole telephone system into its own hands on terms that were fair to the subscribers and calculated to meet the requirements of the community, at the same time avoiding paying exorbitantly for the existing lines, into the cost of which "watered" capital and payments for expired patents entered largely; (2) to maintain the present monopoly; (3) to grant additional licenses and allow municipalities and others

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possessed of spirit enough to find the necessary money, to share in the development of the country and give it the benefit of their enterprise unhampered by superfluous and "watered" capital. The continuance of the present state of things was impossible, and he called upon the Government to make a definite choice of the course to be pursued, and then to follow it with decision and a liberal interpretation of public requirements. Monopolies he did not like, but if a monopoly was necessary, he thought that it should be in the hands of the State, which was, in a certain degree, amenable to public opinion, and not in those of a private company.

Sir Frederick Bramwell said that he was old enough to recollect the controversy which raged around the proposal that the Government should acquire the telegraphs, and he remembered that one of the strongest arguments advanced in favour of that step was that, while companies were prone to serve only important towns and localities from which a paying traffic could be derived without much outlay or trouble the Government would provide telegraphic facilities in smaller towns where profits could hardly be easily acquired, since the benefit of the community as a whole would naturally be regarded more than immediate returns. That was the theory. The practical outcome, however, was that if the inhabitants of a small town or village wanted the telegraph the Post Office said: "We will put you in the telegraph on condition that you give us a seven years' guarantee that we shall suffer no loss So much is required to cover expenses. If the receipts fall short of this you must make the deficiency good." That rule had been enforced in a village in which he was interested. The guarantee had been given, and the Post Office had erected a wire, and put a telephone at the end of it in lieu of the usual telegraph instrument. The receipts did not cover the guarantee, and for the past two years he had been called upon for his share of the deficiency. That was how the Government treated the telegraphs; possibly they would act similarly in regard to the telephones if they got them—he could not say. But he must own that he thought General Webber placed too much emphasis on the importance of agricultural communication. There were, he thought, few agricultural matters that called for prompter treatment than the postal service afforded, and the fact that the guarantee required in the village he had referred to had to be made good, showed that the villagers did not much care for the telegraph when they had got it. Why, then, should they act differently with regard to the telephone?

Mr. Robertson said that, as one possessing a good knowledge of the shortcomings of the existing systems of communication in Suffolk, he could not endorse the conclusions of the last speaker. The scheme of a telephone system for Suffolk, which General Webber had prepared and put before them was, in his opinion, eminently calculated to facilitate intercourse throughout the county and to benefit its trade. The telephone was not on all fours with the telegraph. As he understood it, General Webber proposed to bring some dozens of small places which were not touched by the telegraph at all into connection by means of the telephone; he would therefore provide local communication, which the telegraph did not. Villagers did not often want to telegraph to strangers at great distances, hence the small use they were apt to make of the telegraph; but if they could communicate readily amongst themselves and immediate neighbours in the county a different state of things would arise, and it was certainly premature to foredoom to failure an experiment which had never been tried. At the same time some degree of education in the uses of the new facility would probably be required, and he was not prepared to say that the scheme would prove remunerative from the outset, although he believed it would be so later on.

Prof. A. C. Elliott said that he was struck by the facts regarding foreign telephonic progress set forth by Mr. Bennett, and would be glad to learn whether this gentleman was prepared with any scheme for remedying the existing unsatisfactory state of things in the United Kingdom.

General Webber, in replying to the chairman, said that at first he had been sorry to hear his proposals characterised as Utopian by the chairman, but on reflection, was quite content because no new proposal had ever been brought forward in this country that had not at first been stigmatised as Utopian. That applied to every important industry and invention that could be named, and he could not expect better treatment than had been accorded to railways and telegraphs. His scheme for Suffolk might be styled Utopian, but what were the facts? He proposed 26 telephone exchanges for Suffolk, and Mr. Bennett's map of Luxemburg showed that 59 exchanges already existed in that country, the area of which was less than that of Suffolk; and that each and all of these were connected by trunk lines. There could be nothing Utopian about his scheme therefore, for it was already excelled elsewhere. He was sorry Mr. Preece had taken no part in the discussion, and supposed he was deterred by his official position. Nevertheless, he should have liked to have heard Mr. Preece's opinion, as an engineer, of the figures he had put forward and which he had been told were, if anything, over than below the mark. If Sir Frederick Bramwell could become acquainted, as he wished he could, with the very numerous agricultural friends which he (General Webber) possessed in Norfolk and elsewhere, he would alter his opinion as to the country people not understanding or requiring the telephone. On the other hand, he had been the recipient of many communications which showed that the exact contrary was the case; they fully appreciated its conveniences, and regretted that the opportunities of taking advantage of them were withheld.

Mr. A. R. Bennett said that he would like to explain that his paper had not been written in concert with General Webber. The General had evolved his scheme for Suffolk, and he (Mr. Bennett) had independently prepared his own paper, which accidently, but none the less, he thought, appositely, showed that the General's ideas were not only not Utopian, but had actually been given effect to, not in one, but in many places abroad. As an Englishman, he could not regard with complacency English counties like Dorset represented by blank spaces on the telephonic map, while Luxemburg, Finland, Norway, and other countries were shown in an advanced state of development. He had heard the remarks about the want of understanding and enterprise said to characterise the British peasant and the British agriculturist, but he would not for one moment admit that the inhabitants of Suffolk or Dorset or Jersey were one whit less intelligent or less disposed to take advantage of modern improvements than Finns, Norwegians, Luxemburgers, or any other foreigners whatever. The differences in the results obtained were due entirely to the differences in the modes of administration and the opportunities afforded. The telephone in this country had been made a mystery of, and by means of exorbitant prices the impracticable regulations had been removed from the ken of those of moderate means. Abroad, matters had been differently managed, and foreigners were consequently in possession of aids to trade which were denied at home. During his long experience he had had many opportunities of judging of the utility of the telephone for general and agricultural purposes, and his earnest advocacy of a free extension and more liberal measures was the outcome of this experience That experience also taught him that General Webber's estimates for constructing the proposed lines in Suffolk were sufficient, and were even rather more than sufficient. He had no doubt that the work, under competent supervision, could be done, and done well, for the sum named. In reply to Prof. Elliott, he thought that the methods that had placed the Scandinavian countries at the head of well-telephoned countries were those which should be at least tried in this country. It was evident that the characteristics of management which had produced such good results were not reconcilable with any form of monopoly, and he would certainly recommend the Government to see what a freer trade in telephones would accomplish before deciding on either the first or the second alternatives suggested by Prof. Silvanus Thompson.

The **Chairman** said that the state of development attained in Luxemburg and other countries mentioned was certainly remarkable, and pointed to greater possibilities at home than he would have anticipated; but the telephone was not a branch of engineering which had come much within the scope of his experience, and he was perhaps hardly competent to judge. He could scarcely appreciate General Webber's point when he attributed depletion of agricultural districts partially to the action of the post and then proposed to cure it by means of the telephone. But all would agree that the development of telephonic communication in this country was greatly to be desired, and they must hope to see it speedily brought about.

THE MODERN APPLICATION OF ELECTRICITY TO TRACTION PURPOSES.*

BY PHILIP DAWSON.

(Continued from page 326.)

In 1890 there were 2,523 miles of electrically-operated track and 5,592 motor cars within the U.S.A. and Canada. In July, 1895, 10,752 miles of trolley wire had been erected furnishing current for 35,004 electric cars. Approximately, these figures mean an investment in equipment of £50,000,000 sterling.

European progress has been more slow. This is not unnatural, for there has been no such pressing necessity felt upon this side of the Atlantic under the more settled conditions which here prevail. In 1890 about 60 miles of electric lines were in operation. To-day there are approximately 500 miles of elevated conductors and 1,500 motor-equipped cars, while the lines under contract easily equal, if they do not considerably exceed, the sum total of all that has heretofore been completed. The results are set forth in accompanying tables, which, while undoubtedly incomplete, embody the latest information obtainable (see Table IV.).

By far the greater proportion of European electric tramway installations are to be found in Germany, but during the past year great activity has been shown in France as well. Comparatively little has yet been done in the British Isles, but there is every present appearance of extensive installations being shortly undertaken. Dublin, Bristol, and Coventry are already in hand, and will probably have cars running during the present month. The electric tramways of the Isle of Man, South Staffordshire, Leeds, and Guernsey are undoubted successes.

No other European country can, however, show such applications of electrical motive power to distinctively railway work as are to be found in the Liverpool Overhead Railway or the City and South London Underground.

On the question of tramways in general, the attitude taken in Great Britain is distinctly opposed to that of all other countries. It may be safely said that wherever else we turn we find the tramway regarded, if not as an unmixed blessing, certainly as an indispensable public convenience. British

* Paper read at the meeting of the British Association at Ipswich.

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regulations are by far the most severe, and it is difficult to see why their stringency should not be relaxed to some extent. Our theory would seem to be that all other vehicles must necessarily take precedence of the tramcar. It would certainly seem, in this democratic age, that the vehicle which most greatly conduces to the comfort and convenience of the public at large should be accorded a better place.

With the gradual change from animal to mechanical means of traction, most, if not all, of the objectionable features of the tramway have been eliminated. Its social status has been distinctly raised in the public estimation, as its importance as a factor in municipal economy has won recognition. The great cable and electric systems of America have equal dignity with the steam railways of the country, represent enormous financial investment, and are much more closely connected with the daily life of the people.

If American and Continental experience has proved anything, electricity surpasses all other methods of motive power in its general fitness for tramway and light railway service. It admits of a constant service of comparatively light cars or trains at reasonable cost, of wide variations of speed, of elasticity sufficient to meet the demands of great temporary increase in passenger traffic, of re-equipment without extensive interference with the highway, existing cars, or any public service.

It is essentially clean, safe, and controllable, and no specially high class of employés are required in any department of a line. It has distinctly passed the experimental stage in every detail, and the apparatus has reached the point where interchangeability of parts and ease and simplicity of repairs can scarce be carried further. Every possible accessory is highly developed.

Curves, grades, switches, crossings, main and branch line service present no difficulties to-day, however greatly they may have impeded the pioneers in the development of electric traction.

All that has been said is especially applicable to the trolley wire system, which is the only one that has received any wide acceptance. The conduit has still to demonstrate its efficiency on a large scale, although Budapest and various Continental and American trial lines are now in operation. It may be considered certain that no sub-surface system will ever equal the elevated conductor, from the operator's point of view. Manifold difficulties in insulation, points and crossings, and connection between conductors and motors must be overcome. Moreover, it is more than doubtful whether the trolley wire and its supports are sufficiently objectionable to compensate for the great expense and manifold disadvantages attendant upon reconstruction of roadway and interference with existing sub-surface sewers, gas and water pipes and mains, telegraph, telephone, and lighting cables, etc. There is no reason to presume that an electric railway conduit should be cheaper or smaller than a cable railway conduit. Drainage requirements are the same, and the question of effective insulation resolves itself largely into one of sufficient space. At all events, America is the home of both cable and electric railways, and we note that the engineers having now in hand the installation of trial electric conduit lines, are rigorously following the most substantial form of cable construction. In the English climate it is well known how great the difficulty is of securing proper insulation, and it would seem certain that we could not afford to put in anything smaller or less costly than is apparently deemed to be necessary across the Atlantic.

At all events, it may be taken—to quote Prof. Silvanus Thompson—that of all overhead wires the trolley is the least unsightly, and has the best excuse for its existence.

The "third rail" system is applicable only to lines where the public has no access to the permanent way, or to toy lines employing currents of extremely low potential.

In fact, a paper dealing with modern electric traction, without speculative reference to future developments, must be solely confined to the trolley system, and we will therefore proceed to discuss its component parts.

Power Plant.—Upon the location and design of the generating station (with reference to the centre of current distribution) and the selection of the apparatus used therein, primarily depend the efficiency and economy of the whole system. The load is constantly varying, widely and unexpectedly, and the smaller the line, the greater the fluctuation, and the consequent reserve power required. An electric tramway operating five cars might easily need 35 station indicated horse-power per car, while a 50-car road should not require more than 15 i.h.p. per car in the power-house. For units under 500 h.p., high-speed rope-driven engines can advantageously be employed. Larger units require slow-speed direct-coupled engines of the Corliss type. Whatever the engine it must be built especially for the work in question, and able to stand overloading to the extent of nearly double its normal output. In fact, the strains to be met approximate those to which the engines of a rolling-mill are subjected. Extra heavy flywheels are always employed. Governors should be so constructed that under any variation of load the speed should remain constant within 2 per cent.

The dynamo must also withstand heavy overloading, and as one pole is earthed the best insulation must be employed. Very heavy magnetic inductions are allowed for to avoid sparking and the necessity of shifting brushes. From every point of view the over-compounded type of generator is the best. The design should be such that at no load the pressure between terminals should be 500 volts, increasing to 550 volts as the full load is thrown on.

When the ordinary practice is to employ compound-wound machines in parallel in the two-wire system, the three-wire system has been successfully adopted at Portland and St. Louis (U.S.A.), two generators being connected in series, one wire attached to the rails and the other two to alternate insulated sections of the trolley wire. The result has been to notably reduce the current in the rails, and consequently the section of feeders. Very considerable difficulty has, however, been found in maintaining a proper balance.

As it often happens that single feeder cables are called upon temporarily to carry exceedingly heavy currents, automatic circuit breakers must be placed in all circuits.

The motors employed must be light, strong, and simple in construction—completely encased—able to run continuously for hours at rated capacity without undue heating, and to exceed that capacity by 50 per cent. when required without injury. The starting torque must be great. The average horse-power exerted by a motor at the car wheel probably does not exceed 20 per cent. of the maximum power it is expected to exert in starting a car under various conditions.

To get the best efficiency out of such a motor, it is necessary to have its point of highest efficiency at that horse-power at which the greatest amount of work is to be done. To minimise the losses through hysteresis, eddy current, and friction, and at the same time to obtain the required torque, it becomes necessary to use the greatest number of armature-turns compatible with easy running and absence of heat and sparking. To ensure the latter it has been found necessary to use very heavy magnetic inductions, such as 100,000 C.G.S. lines of force per square inch in the yoke, 60,000 C.G.S. lines in the air-space, and 80,000 C.G.S. lines in the armature core.

It is universally considered that the drum armature, wound so that coils of different potential do not cross each other ("Eickemeyer") is most advantageous. All coils are made separately on forms and then bound down into wedge-shaped grooves cut in the face of the armature core. The use of paper insulation between the armature discs has been discarded, and the formation of Foucault currents is prevented by heating the discs, thus covering their surfaces with a black oxide which suffices as insulation.

The standard motor used on European and American electric lines weighs approximately 1,500lb., and is rated at 25 h.p.; that is to say, it will exert a horizontal effort of 800lb. through a 33in. wheel continuously.

Every variety of gearing has been tried in turn, in order to secure the most efficient method of reducing the speed of the armature and transmitting its action to the car axles. Double and single reduction spur gear, bevel gear, belts, single and double chain gear, and worm gear, have all been submitted to most extensive tests. Practically, all motors are now standardised on the single reduction spur and pinion, from which gearing an efficiency of approximately 95 per cent. is now obtained. The pinions are of steel, and the spur wheels of cast iron. Epicycloidal teeth are almost universally employed. The gears are always run in oil, and the life of the pinions and spur wheels, which in the old double-reduction type of motor was respectively 9,000 and 29,000 miles, has been more than doubled.

Practically, the only method of control now employed in traction work is the series-parallel system. This consists in the use of two or more motors per car, which by means of a special device are thrown into different combinations. These are shown in the diagram, and a typical controller is before you. The introduction of the series-parallel controller has resulted in a very great saving of power at starting, while four different speeds are attained without the waste of current in the resistances previously employed, and with a high efficiency in the motors. Reversal is effected by a separate switch, and interlocking gear prevents the motors being reversed until the current is turned off.

We have before us a model motor truck, showing the standard construction now utilised by most large American roads, and which is also employed by all the English tramways now under electrical construction. The model is so made as to show three styles of truck employed for supporting cars of different lengths, and it is fully equipped with two "G.E. 800" motors, and their gearing. It may be said that the introduction of electric traction has revolutionised running gear. The great addition to weight made by the motors and gearing has rendered it necessary that efficient methods be used for cushioning and suspending the motors upon their axles, while maintaining a rigid connection between motor and axle. Consequently the truck is to-day made so that it relies not at all upon the car construction for strength or support of the mechanism. The use of a reliable and efficient truck is quite as important as the employment of well-constructed motors. You will see that the design of the

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TABLE IV.—ELECTRIC LINES NOW IN OPERATION IN EUROPE OR BY EUROPEAN CONSTRUCTORS. (*a*)

—	Name of town.	When opened.	Miles of track.	Maximum gradient.	Smallest radius in feet.	Gauge of track.	No. of motor cars.	No. of trailer cars.	Tension in volts.	No. of kilowatts.	Number of engines.	No. of boilers	Indicated H.P.	Type of steam-engine.	No. of dynamos.	How driven.	Maximum speed in miles per hour.
1	Liverpool (overhead) (*b*) (*e*)	Mar , 1893	13	1 in 40	462	Standard	40	—	500	—	4	—	1,600	Horizontal compound condensing	4	Rope	30
1	South Staffordshire	Jan., 1893	8	1 in 40	40	3ft. 6in.	16	—	300	—	3	—	375	Horizontal compound.....	3	Rope	8
2	Bessbrook, Newry	Oct., 1885	3	1 in 50	55	3ft.	3	12	250	—	1 (turbine)	—	62	Turbine	2	Belt.....	—
2	City and South London(*b*)(*e*)	Dec., 1890	6½	1 in 30	—	Standard	16 loco	36	500	225	4	8	1,600	Vertical compound.....	4	Belt.....	25, average 13·5
2	Douglas and Laxey.....	Aug., '93-4	14	1 in 20	90	Narrow	13	12	500	—	5	—	450	Compound condensing	5	Belt.....	—
3	Portrush (*b*)	1883	6	1 in 30	—	—	5	—	250	—	2	—	104	Turbines	2	Belt.....	—
3	Guernsey	Mar , 1892	3	1 in 40	75	Standard	7	2	500	—	2	—	160	Semi-portable compound	2	Belt.....	10
3	Panama	1893	2	1 in 24	45	—	7	—	440	—	3	—	60	—	2	—	—
3	Hobart Town	Sept , 1893	8½	1 in 17	70	—	20	—	500	—	2	—	600	High-speed vertical	3	Direct coupled	—
4	Brighton Beach (*b*).....	Aug . 1893	1	1 in 14	—	3ft.	2	2	100	—	1	—	12	Gas-engine	1	Belt.....	—
5	Blackpool (*f*)	1884	1	—	—	—	—	—	220	—	2	—	50	Semi-portable compound	2	Belt and shaft	—
6	Southend Pier (*b*)	Aug., 1890	1¼	—	—	—	3	3	200	—	—	—	—	—	2	Belt.....	14
7	Bremen	May, 1892	10	1 in 33	66	Standard	28	15	500	75 and 90	3	3	450	Horizontal compound.....	3	Belt..	8 to 10
7	Remscheid	Aug., 1893	5¼	1 in 10	60	Metre	13	—	500	—	4	3	450	Horizontal compound.....	2	—	—
7	Hamburg	Mar., 1894	26	1 in 20	60	Standard	160	150	500	—	3	—	170	Two continuous-current trans-	1	—	—
7	Gotha	May, 1895	1¾	1 in 25	60	Metre	6	—	500	—	—	—	—	— [formers and one engine.	—	—	—
7	Erfurt	June, 1894	7	1 in 16	48	Metre	29	17	500	100	3	3	450	—	3	—	—
7	Brussels	May, 1894	18	1 in 16	66	Standard	88	47	500	350	8	7	900	Horizontal compound.....	8	Belt.....	—
7	Leeds	Nov., 1891	5¼	1 in 20	—	Standard	6	—	300	—	1	1	200	McIntosh and Seymour high-speed	2	Belt	8
7	Milan	Sept , 1893	4½	1 in 25	50	—	16	—	500	100	2	—	300	Vertical compound.....	2	Belt.....	—
7	Lyons.....	July, 1894	3·75	1 in 15	—	Standard	10	—	500	200	2	—	400	—	2	—	—
7	Havre.....	July, 1894	8·75	1 in 18	—	Standard	40	—	500	200	3	—	900	Corliss condensing	3	Rope	—
7	Bordeaux	1893	3·6	—	—	Metre	8	—	—	100	2	—	300	—	2	—	7½
7	Roubaix.....	Dec , 1894	10	—	—	Metre	18	—	500	100	3	—	450	—	3	—	—
7	Florence.....	April, 1891	5	1 in 12·5	60	Standard	12	—	500	—	3	—	270	Vertical compound.....	3	Belt..... ...	—
7	Liège	1893	2	1 in 30	82	—	5	—	550	—	2	—	240	—	2	Belt.....	—
7	Belgrade	1894	6·25	1 in 16	—	—	11	—	500	100	2	—	300	—	2	Belt.....	8
7	Munich	1895	1·5	—	—	—	12	—	—	—	—	—	—	—	—	—	—
8	Budapest (*f*)	July, 1889	16	1 in 30	72	Standard	92	10	300	Each 4 at 130 ,, 3 at 65	7	—	1,100	—	7	Three rope / Four direct	11
8	Budapest (suburbs).....	Oct., 1893	10½	1 in 50	157	Standard	20	—	300	—	—	—	800	—	—	—	14
8	Hanover	May, 1893	14½	1 in 25	29½	Standard	32	12	500	130	2	—	400	Horizontal compound.....	2	Direct.....	18
8	Dresden	July, 1893	7½	1 in 29	49	Standard	16	16	500	80	2	—	240	Horizontal compound	2	Direct -	19
8	Genoa.....	May, 1893	1¼	1 in 15	131	Metre	4	—	500	100	1	—	150	Vertical ..... -	1	Belt.....	8
8	Barmen Rack Railway	April, 1894	2	1 in 5	492	Metre	8	—	500	130	3	—	606	Horizontal compound condensing..	3	Direct.....	4½
8	Barmen	Sept., 1894	1¾	1 in 18	72	Standard	7	—	500	—	—	—	—	Transformers from lighting station	—	—	10
8	Mulhausen	July, 1894	3	1 in 35	49	Metre	9	7	—	—	—	—	—	—	—	—	12½
8	Lichterfeld (*b*)	May, 1881	12	1 in 23	56	Metre	10	4	500	Each 3 at 15 ,, 1 at 45	3	—	150	One portable / Vertical	4	Belt.....	10
8	Lemberg	May, 1894	6	1 in 14	56	Metre	16	—	500	150	2	—	400	Compound condensing	2	Direct coupled.	8
8	Bucharest	Nov., 1894	4	1 in 40	49	Standard	6	—	500	50	2	—	150	Compound.....	2	Belt.....	10
8	Mödling (*d*)	Oct., 1883	4	1 in 66	98	Metre	8	7	500	20	4	—	186	Portable.....	6	Belt and shaft.	14
8	Frankfort (*d*)	1884	4½	1 in 32	98	Standard	10	6	300	20	2	—	100	—	4	Belt..... ...	—
8	Serajewo	May, 1895	4	1 in 66	98	metre ·760	5 loco.	8	300	65	—	—	—	—	1	—	—
8	Bochum	Dec., 1894	4½	1 in 54	49	Metre	5	4	500	50	2	—	150	—	2	—	—
8	Basel	May, 1895	2	1 in 20	49	Metre	12	5	500	45	2	—	150	—	2	—	—
9	Mont Salève Rack Rly. (*b*) .	1892	5¾	1 in 4	114′ 9″	Metre	12	—	600	165	2	—	500	Turbine	2	Direct.....	5
9	Clermont-Ferrand (*d*)..... ...	1890	4½	1 in 22	83	Metre	22	—	550	165	2	—	1,000	Compound.....	2 exciters	—	13
9	Stans	1893	2	1 in 9	164	Metre	3	—	550	33	1	—	150	Turbine	1	Belt..	33
9	Chavornay	1894	2½	1 in 40	493	Metre	1·45	3	—	550	45	1	—	70	Turbine	1 exciter	—	—
9	Lyon Ecully	1894	2	—	65	Metre	3	—	550	70	1	—	110	—	1	—	—
9	Geneva	1894	3¾	1 in 18	82	Metre	8	—	550	152	2	—	440	—	2	—	—
10	Baden-Vöslau	July, 1894	6	—	—	Standard	9	9	500	—	—	—	—	—	—	—	7 to 12
10	Zwickau Sax.	June, 1894	4½	1 in 28·6	72	Metre	11	—	500	—	2	—	300	Horizontal compound condensing.	4	Belt.....	—
10	Blasewitz	Oct., 1893	—	1 in 33	12	—	9	8	—	—	2	—	340	—	—	—	12

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	Mürren (c)	Aug., 1891	2½	1 in 20	98	Metre	4	4	600	90	1	—	150	Turbine	1	Direct	—	
	Marseilles	1892	8	1 in 18	50	Standard	18	—	550	500	3	—	750	Horizontal compound	3	Belt	8	
12	Sissach Gellerkinden (c)	May, 1891	2	1 in 80	196	Metre	1	8	700	35	1	—	40	Turbine	1	Gearing	10	
	Zürich Central	Feb., 1895	2½	1 in 18	49	Metre	14	—	550	44	2	—	240	Gas	2	—	—	
	Zürich	Mar., 1894	3	1 in 18	49	Metre	16	—	550	66	2	2	360	Vertical	2	Belt	7	
	Halle	May, 1891	10	1 in 20	—	Metre	36	13	500	60	2	—	350	Horizontal	4	Belt	—	
	Gera	Feb., 1892	6	1 in 20	—	Metre	22	16	500	45	3	—	525	Vertical combination	6	Belt	—	
	Kiew	May, 1891	8¾	1 in 95	—	Standard	39	—	500	60	4	—	700	Vertical combination	8	Belt	—	
	Breslau	June, 1893	11½	1 in 40	—	4ft. 7in.	55	40	500	60	3	—	600	Vertical combination	6	Belt	—	
	Essen	Aug., 1893	13½	1 in 16	—	Metre	24	17	500	60	2	—	400	Vertical combination	4	Belt	—	
	Chemnitz	Dec., 1893	13	1 in 30	—	Metre	28	20	500	60	2	—	350	Vertical combination	4	Belt	—	
13	Christiania	Mar., 1894	4¾	1 in 15	—	4ft. 7in.	15	7	500	60	3	—	300	Vertical combination	3	Belt	—	
	Dortmund	April, 1894	7	1 in 40	—	4ft. 7in.	30	20	500	60	3	—	600	Vertical combination	4	Belt	—	
	Lübeck	May, 1894	8½	1 in 20	—	3ft. 7in.	28	20	500	60	3	—	450	Vertical combination	4	Belt	—	
	Plauen	1895	2·2	1 in 12	—	Metre	9	—	—	72	2	—	200	—	2	—	—	
	Konigsberg	1895	1·84	1 in 24	—	Metre	8	—	—	72	1	—	100	—	1	—	—	
	Relenberg	1895	3	1 in 11	—	Metre	7	—	—	45	3	—	330	—	6	—	—	
	Strasburg	1895	3·6	1 in 70	—	Standard	18	—	—	100	3	—	300	—	3	—	—	
18	Blasewitz	Oct., 1893	2½	1 in 33	12m.	—	9	8	400	—	2	—	340	—	—	—	9½	
	Vevey-Montreux (d)	1888	6¼	—	—	Standard	—	—	—	—	1	—	240	Turbine	—	—	8	
14	Teplitz Ecchwald	July, 1895	5¼	1 in 18	120	Metre	8	6	500	200	3	2	540	Steam-engines	2	Direct coupled	—	
	Bielitz, Liegeunerwald	Oct., 1895	3½	—	—	Metre	6	2	550	100	1	2	180	Vertical tandem	1	—	—	
	Pozsony	1895	1	—	65	Metre	5	5	550	132	2	—	170	—	2	—	9¼	
	Bleiberg	—	1¾	—	65	19in.	2	10	200	3·3	—	—	10	Turbine	—	—	—	
	Mizserfa	—	1	1 in 19	91	24in.	2	15	330	10	1	—	70	—	1	—	—	
15	Maros-Szlatina	—	6½	1 in 19	98	3ft. 7in.	1	2	550	55	1 partly used	—	—	—	1	—	—	
	Esolanyos	—	2½	1 in 25	82	29in.	1	2	550	15	1	—	30	—	1	—	—	
	Raglyas Alja	—	2	1 in 30	114	24in.	2	60	550	110	2	—	160	—	2	—	—	
	Resitza	—	2½	1 in 20	72	27in.	1	40	550	55	1	—	81	—	1	—	—	

Lines constructed by (1) the Electric Construction Company; (2) Messrs. Mather and Platt; (3) Messrs. Siemens Bros.; (4) Mr. Magnus Volk; (5) Mr. Holroyd Smith; (6) Messrs. Crompton and Co.; (7) Thomson-Houston System; (8) Messrs. Siemens and Halske; (9) Compagnie de l'Industrie Electrique, Geneva; (10) Messrs. (Schuckert) Electricitäts Actien-Gesellschaft; (11) Messrs. the Maschinenfabrik Oerlikon; (12) the Allgemeine Electricitäts-Gesellschaft, Berlin; (13) Messrs. Kummer and Co., Actien-Gesellschaft, Dresden; (14) Internationale Electricitäts-Gesellschaft, Vienna; (15) Messrs. Ganz and Co., Budapest.

(a) Where not mentioned otherwise the overhead conductor is used. (b) Third-rail conductor. (c) This line runs electric locomotives. (d) Overhead conductor is a slotted copper tube in which collector slides. (e) The cars form a train, each car with motors wound directly on axles. (f) Conduit system.

LINES UNDER CONSTRUCTION.

By Messrs. Siemens and Halske.

Name.	Length.	Gauge.	Voltage.	No. of Motor cars.	H.P.
Budapest	12	Standard	300	—	2,400
Budapest, underground	2½	Standard	300	—	—
Dresden	30	Standard	500	57	—
Pankow	2½	Standard	500	8	300
Barmen	2	Standard	500	—	—
Gelsen Kerchen	17¾	Metre	500	—	—
Messrs. Kummer and Co., Actien-Gesellschaft, Dresden.					
Fenbach	7½	—	400	6	275
Messrs. Electric Construction Company.					
Madras	9½	—	500	30	360
Hartlepool	2½	—	—	5	200
Messrs. General Traction Company, Limited.					
Coventry	6	3′ 6″	—	8	250
Messrs. Schuckert and Co.					
Aix-la-Chapelle	—	—	—	—	—
Ulm	2½	—	—	8	—
Dusseldorf	2	—	—	8	—
Messrs. Ganz and Co.					
Budapest and Ujpest	8½	Standard	—	10	480

The Allgemeine Electricitats-Gesellschaft.

Name.	Length.	Gauge.	Voltage.	No. of Motor cars.	H.P.
Spandau	4	Metre	—	24	290
Genoa	10	Metre	—	67	1,200
Kiel	7½	3′ 7″	—	33	600
Dantzig	11½	4′ 8″	—	35	600
Stuttgart	7½	3′ 3½″	—	50	—
Chemnitz	4½	Metre	—	10	75
Leipzig	27½	4′ 8″	—	70	1,000
Bilbao	99¼	4′ 5″	—	28	525
Bromberg	10	Metre	—	16	450
Lubeck	2½	3′ 7″	—	4	—
Internationale Electricitats-Gesellschaft Vienna.					
Bielitz	3	Metre	350	6	180
Cie. de l'Industrie Electrique Geneva.					
Aubonne	1½	Metre	350	2	100
Lausanne	8½	Metre	550	14	520
Maschinenfabrik Oerlikon.					
Tettnang	2¾	Standard	—	2	250
Nijni Novgorod	1½	Metre	—	15	1,350

Thomson-Houston System.

Name	Length.	Gauge.	Voltage.	No. of Motor cars	H.P.
Hamburg Extension	18½	—	500	87	2,500
Elberfeld	2½	—	500	12	—
Barmen	7	—	500	65	—
Wiesbaden	1½	—	500	7	—
Elbing	2½	—	500	10	—
Leipzig	25	—	500	135	—
Liège	7¼	—	500	40	—
Rome	1½	Standard	500	10	—
Brussels	4	—	500	20	—
Bristol	7	Standard	500	12	400
Dublin	16	5′ 3″	500	20	600
Lyons, St. Fons	5½	Standard	500	10	150
Lyons, Reseau	23½	—	500	100	2,500
Rouen	20	Standard	500	10	900
Montfermeil	3½	Metre	500	4	100
Pessac	3½	Metre	500	50	300
Varese	3	Standard	500	5	150
Algiers	5¾	—	500	10	300
Oporto	1½	Standard	500	3	150
Cairo	25	—	500	50	—
Munich II	1¾	—	500	8	—
Mussoco	3¼	Standard	500	5	150

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model truck is practically that of a continuous truss such as would be used in cantilever bridge work. Every care is taken to evenly support the car body for its whole length, and to use such springs at the different points as will most readily accommodate themselves to both heavy and light loads. It has been found that the four-wheeled truck can be satisfactorily used for the support of car bodies up to 22ft. in length. For longer bodies bogie and radial trucks are employed. Many different type of bogies have been employed in order to get the maximum traction weight upon the driven axles; but as yet no one can say positively which of the several variations is the best. The six-wheel radial truck has been largely introduced with the desire of doing away with the waste of power due to skidding and grinding of the wheels on curves of small radius. It is composed of three independent two-wheel trucks pivoted together, the two end trucks carrying the greater part of the load and the motors. It cannot yet be said that this truck is wholly satisfactory, as it has a tendency to derailment. It is indispensable that mechanically-propelled cars in populous cities should be provided with thoroughly reliable safety apparatus, and you will note how very substantially the brakes upon the model truck are made. Several different systems of supplementary braking apparatus are in use, and on all roads operating heavy grades it is customary to employ air, electric, or additional track brakes to supplement the ordinary hand brakes. Safety fenders of many different types are also used to prevent the possibility of any person getting under the wheels, should he fall in front of a moving car. Sand-boxes, actuated by levers on the driver's platform, are alway provided.

The British tramcar, having seats on the roof, requires a somewhat different style of trolley from that usually employed on American and continental lines. Both types are before you, and it is scarcely necessary to further explain them. You will see that swivelling arrangements are provided whereby the trolley will easily and certainly follow the trolley wire from a point directly above the car roof to a point of 8ft. to 10ft. off to one side of the track. This adaptability of the trolley to a considerable variation of the wire from a direct line greatly simplifies construction, and enables the wire (as at Bristol and South Staffordshire) to be hung from short arms along one side of the track. In a few cases constructors have preferred to use scraping contacts, running along the underside of the wire rather than the wheel, but the great mass of opinion is strongly in favour of the use of the wheel contact.

Such adverse criticism as has been made upon the use of elevated wires for electric tramway service has largely arisen from carelessness in erection, and, in the earlier days, from the fact that the various accessories were still in an experimental stage, and unsightly apparatus was made up on the spur of the moment to meet exigencies as they arose. The first electric lines, both European and American, were great sinners in this respect, and the clumsy cobwebs of wires which they erected were undoubtedly most objectionable. With the enormous increase in traction business, it became worth while, from a business standpoint, for many expert mechanics to devote themselves to the elaboration of these details, and to the perfection of the apparatus required in their manufacture. Special poles, insulators, suspension devices, and all the many appliances required for crossings, branches, terminals, etc., have consequently been developed, and have greatly added not only to the efficiency of equipment, but to ease in erection and workmanlike appearance. A set of approved apparatus, such as is used in the construction of various British lines, is before you, and you will note that they are compact, strong, and not likely at a height of 21ft. in the air to be unduly conspicuous. In many Continental cities, the municipal authorities have prescribed that in all cases, where possible, the span wire supporting the trolley line should be attached directly to the house fronts by means of rosettes of ornamental design. Injurious effects to the buildings from vibration is avoided by the insertion of springs or indiarubber cushions. When this method is used all objectionable features are minimised to the greatest possible extent.

The span-wire system of construction, by which the trolley wire is held directly over the tracks is undoubtedly the most efficient, especially where high rates of speed are to be run through broad streets. Where the tramway track is along a single side of the highway, suspension from single bracket arm poles possesses the same advantages.

Much has been done on the Continent and in England in developing handsomely ornamented poles, which do not detract from the appearance of the street, and in many places electric arc and incandescent lamps are supported upon the same poles as carry the tramway wires. Several designs now in use are illustrated in the drawings before you. The employment of underground feeders adds much to the sightliness of the installation.

For a separation of a line into sections so that an accident upon one portion may not interfere with the whole line for protection against lightning, etc., ingenious apparatus has been developed, samples of which are on the table. In a few places double conductors are employed in order to avoid the necessity of using the rails for the return circuit, and the consequent bonding of joints required. These are, however, isolated instances, and the only large system worked in this manner is that of Cincinnati. It will easily be appreciated that such advantage as may be secured by the use of a double overhead conductor, is more than compensated for by the resultant increase in the number of wires suspended over the street.

To ensure an easy path for the return current is of great importance, and on the earlier roads, which largely trusted to the earth as a return, very serious difficulties were soon encountered. Heavy currents of electricity circulating through the metallic pipes and conduits along the line of the route caused their rapid corrosion. At first, enormous falls of potential were allowed, but nowadays it is rare that the fall of voltage on any line is allowed to exceed 20 per cent. British practice is, of course, governed by the rules of the Board of Trade, which specifies that the fall must not exceed seven volts.

It has now been definitely ascertained that heavy copper joints between the ends of the rails should always be employed and the rails relied upon for the return to the extent of their current-carrying capacity. When that is exceeded, insulated return-circuit feeders should be run back to the power-house. Bare copper supplementary wires laid the length of the track are utterly useless. The latest and most approved form of bond is the "Chicago" rail bond, which during the past year has come into very extensive use in Europe as well as in America. It consists of a copper rod having tubular terminals, which are inserted into poles through the web of the rail. The terminals are then expanded and wedged into solid contact with the metal of the rail by driving into each terminal a drift pin about 1-16in. larger than the thimble. This makes as nearly as possible perfect contact between the two metallic surfaces, excluding air and moisture, and preventing corrosion or electrolytic action in the connection. It must be borne in mind that the only contact which can be at all relied upon is that between the bond and the interior surface of the hole in the rail, and that the surface of copper in contact with that surface should be at least six times the section area of the bond.

Electric welding may demonstrate its success as a means for ensuring the return circuit, but it cannot be said as yet whether or no the results have been such as to warrant its extensive introduction. It must stand the test of some years' trial. Over 100 miles of track have been welded at joints in the United United States, and the work is still going on. It is too early yet to form an opinion as to its relative value compared with the system of heavy bonding which has now secured the widest approval. Specimens of bonds are exhibited.

As electric traction is applied on a more and more extensive scale, and great numbers of cars are operated by individual roads, the question of how to distribute current most economically attains great proportions. We have already referred to the three-wire system as having a considerable value. Three-phase distribution is also being tried upon an extensive scale in many places. The Dublin Southern Tramways, on the 8½-mile line which is now being constructed by the British Thomson-Houston Company, will employ a combination of continuous current and of three-phase alternating current transmitted at a pressure of 3,000 volts to two sub-stations respectively 3½ and 8 miles away from the generating station. Each sub-station contains two 60-kilowatt rotary transformers. At Sacramento, Cal., a water power 23 miles away from the line supplies 4,000 h.p. for the needs of that city, current being transmitted at a pressure of 11,000 volts. At Portland, Ore., current at 6,000 volts is transmitted from a water power 20 miles distant from the line. At Lowell, Mass., current generated by steam is transmitted to sub-stations respectively seven and 15 miles from the power-house at a pressure of 5,000 volts. In Switzerland we find several interesting applications of water power carried from a long distance at convenient voltages and transformed for railway and traction use to the ordinary potential of 500 or 600 volts. At Lugano, Messrs. Brown, Boveri, and Co. are undertaking an interesting installation, in which the cars are furnished with three-phase motors. A double trolley wire is used, and the rails act as the third conductor.

All this work is in the direct line which will some day lead to an extensive competition with steam as the motive power for railway services. Throughout America we find extensive application of electric traction to mining tramways, for the electric motor readily adapts itself to the contracted space of galleries and drifts, to the handling of freights in cities, goods yard, and factories. Messrs. Ganz and Co., of Budapest, have done most interesting and valuable work in this particular line.

It is unnecessary to refer to the equipment of the City and South London Railway and the Liverpool Overhead. These have been already thoroughly discussed and described before the learned societies, and the elevated railway at the Chicago Exhibition has also been referred to *in extenso* in the technical Press.

The Metropolitan Elevated Railway of Chicago will shortly be in full operation, running trains of four cars, of which one will be equipped with motors. The weight of the complete

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motor car is nearly 30 tons, and the train complete will weigh approximately 100 tons. The speed, including stops, will be 13 miles an hour with the present equipment, but it is proposed to shortly operate six car trains at a speed of 15 miles an hour. The Baltimore and Ohio Railway have already in operation the first of a number of 96-ton electrical locomotives with which they propose to operate the 2½ miles of tunnels through which their lines run at Baltimore.

The dimensions of these locomotives are as follows:

Number of trucks (per locomotive)	2
,, motors ,, ,,	4
Weight on driving-wheels	192,000lb.
Number of driving-wheels	8
Draw-bar pull	42,000lb.
Starting draw-bar pull	60,000lb.
Gauge	4ft. 8½in.
Diameter of drivers	62in.
Length over all	35ft.
Height to top of cab	14ft. 3in.
Wheel base of each truck	6ft. by 10in.
Extreme width	9ft. by 6½in.
Diameter of sleeve bearings	13in.

Each motor is rated at 360 h.p., and takes a normal current of 900 amperes. An average speed of 15 miles an hour is obtained. The trains handled by these motors weigh approximately 1,200 tons.

Several of the greatest trunk-line railways in the United States have commenced the equipment of short branch lines with electrical plant. The Pennsylvania Railroad Company has 8½ miles equipped with trolley wire, over which their standard cars will be drawn by electric locomotives at a speed of 45 miles an hour. The New York, Newhaven, and Hartford Railroad Company has had some seven miles of electrically-equipped track in operation for some months, with 30-ton 42ft. cars, under the ordinary conditions of steam railway service. Other lines are preparing to follow their example. It is undoubtedly the case that the results obtained in America have conclusively proved that electricity is cheaper than steam wherever comparatively short lines with frequent stops are to be worked, and we are yet far from knowing the limit to which the comparative economy of electricity extends.

There would seem to be no reason why the same results which have been attained in America should not be reached in Great Britain. Certainly European progress seems to indicate that there is little or no difference between the conditions and requirements which must be met on either side of the Atlantic. We hear on all sides the demand for additional light railways, and to postpone their construction is to heavily handicap a great portion of our population in the competition which to-day exists with foreign producers. The tramway as it now is known in this country is behind the times, and our facilities for rapid transit most inadequate. There is much which we can safely take from the experience of other countries in its development and extension.

In the face of the numerous and successful Continental installations, it is impossible to reasonably maintain that the electric system fails to meet the requirements of city and suburban transit to an extent unparalleled by any other means of mechanical traction. The conditions of modern metropolitan life imperatively demand that our ever-increasing population be afforded vastly improved means of intramural circulation. Our over-crowded centres can no longer accommodate the great army of workers and their families, and access to outlying suburban districts should be facilitated by every possible means. For hygienic reasons alone, it is indispensable that the accessible residential zone surrounding our greater cities should be extended to the utmost limit.

The steam railway cannot efficiently or economically fill this demand, and animal traction is hopelessly inadequate. The trolley system does fill it absolutely, and has well-nigh every advantage that can be asked from an ideal system of traction. The overhead wire is its single objectionable feature, and it would seem not unreasonable to say that so comparatively small a drawback is of but little moment compared with many manifest advantages.

ON THE MAGNETIC FIELD DUE TO A CURRENT FLOWING IN A SOLENOID.*

BY W. H. EVERETT, B.A.

The only investigation hitherto published is that for a solenoid of circular section. The investigation, in which the idea of magnetic shells is used, is of a somewhat intricate character, although treated with Prof. Minchin's usual power, and the results are uninviting for practical application. In this paper the subject is approached by a simpler method—namely, by considering the force due to an element of current—and general expressions are obtained which can readily be worked out approximately to numerical values for a solenoid of any form and size. As a particular case, the results give the force components due to any plane circuit at any point in its field. Special application is made to the rectangular (or polygonal) solenoids, as commonly used for field-magnet coils in dynamos, the expressions being in this case integrable, and some numerical results are given. The paper also includes a remarkably simple expression for the force at any interior point due to a circular current.

* Abstract of paper read at the meeting of the British Association at Ipswich.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Tongres.—The Municipal Authorities of Tongres (Belgium) invite tenders by October 12, 1895, for the concession for the installation and working of the electric light in the town.

Paris.—Tenders are invited for the supply of electric cables, in two lots, for the Administration des Postes et des Télégraphes. Particulars are obtainable of the Administration, 103, Rue de Grenelle, Paris, where tenders are to be sent by October 10.

Alexandria.—The Municipal Authorities of Alexandria, Egypt, invite applications by October 1, 1895, for the concession of the tramway lines from St. Catherine Place, through the outer boule-yards, to the projected abattoirs at Mex, with a branch line. Security £E1,000.

Bedford.—The Electric Lighting Committee invite tenders for the supply and delivery of 200 cast-iron lamp columns, carriers, and globes, in accordance with plans and specifications, a copy of which can be obtained at the office of Mr. T. S Porter, clerk, Town Hall, Bedford, on payment of a fee of 5s. Tenders, marked "Electricity," must be delivered to the clerk by October 8.

Goole.—The Urban District Council desire tenders for fixing telephonic communication between Goole and Rawcliffe Bridge, a distance of about three miles, according to specification. Tenders must be sent to Mr. Geo England, clerk, marked "Tender for Telephone," by 30th inst. Further particulars and copy of specification can be obtained on application to the Manager, Gasworks, Goole.

Braila.—The Municipal Authorities of Braila, Roumania, invite tenders by October 2 for the construction and working of a system of electric tramways in the city. Provisional security, 10,000f. This contract was originally fixed for July 29. Tenders are further invited by the Municipal Authorities of Braila for the lighting of the city by electricity or by electricity and gas Provisional security 10,000f.

Chepping Wycombe (Bucks.).—The Urban Sanitary Authority for this borough are prepared to receive tenders from public companies for working the electric order obtained by them within the borough for a term of years and upon approved conditions. Tenders are to be delivered by noon on October 14 next, at the office of the town clerk, High Wycombe, where a copy of the electric order may be seen and further particulars obtained. The Authority do not bind themselves to accept any tender.

Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

Croydon.—The Council are prepared to receive tenders for wiring and for supplying and fixing electrical fittings at the New Town Hall, Courts, and Free Library. Copies of the specification may be obtained upon application to the architect, Mr. Charles Henman, A.R.I.B A., 64, Cannon street, London, accompanied by a deposit of £2. 2s., which will be returned on receipt of a bona fide tender. Plans of the lighting system may be seen at the architect's office, as above, and at the New Town Hall, Croydon. Tenders to be sent to Mr. C. M. Elborough, town clerk, by October 8.

Blackburn.—The Corporation of Blackburn invite tenders for the following: Contract No. 1.—High-tension concentric cables, low-tension triple concentric cables, cast-iron pipes, junction-boxes, drawing in boxes, service-boxes, etc. Specification, conditions of contract, and forms of tender may be obtained at the offices of Mr. E. M. Lacey, 10, Delahay-street, Westminster, on and after September 23, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders, sealed and endorsed "Electricity Extensions," must be delivered at the Town Hall, Blackburn, on or before October 5.

Dundalk.—The Dundalk Town Commissioners invite tenders for erection of an electric lighting installation for the purpose of lighting the town by electricity on or about July 1, 1896, reserving to themselves the right of taking over the plant at the end of a

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term of years—this term to be stated in the tenders. The successful contractor to have the right of supplying private consumers, while the Commissioners will pay a fixed sum yearly for the town lighting—this sum to be stated in the tender also. The Commissioners have obtained a license from the Board of Trade for supplying electric lighting. Tenders will be received by Mr. Edward Farrar, town clerk, Town Hall, Dundalk, up to October 7.

London, W.—The Great Western Railway Company desire tenders, among other stores, for the supply of telegraph instruments, telegraph apparatus, copper wire, G.P. wire, etc., telegraph ironwork and tools, telegraph drysalteries, carbons for electric light, iron wire, acids, alkalies, zinc, telegraph poles, from November 1, 1895, to October 31, 1896. Samples and patterns may be seen on and after 23rd inst. at the office of the stores superintendent, Paddington Station. Specifications, with forms of tender, may be obtained at the office of the stores superintendent at Swindon or Paddington Stations. Tenders, addressed to Mr. G. K. Mills, secretary, Paddington Station, London, and marked outside "Tender for Stores," will be received on or before October 7.

Eccles.—The Corporation invite tenders for the supply and erection complete of the following apparatus and plant: Lancashire boilers; alternating-current dynamos and engines; cables, street boxes, etc.; transformers. Tenders may be sent in for any section or for the whole of the sections, but not for part of a section only. Plans of the district can be seen and copy of the general conditions, specification, and form of tender can be obtained on deposit of £5. 5s., which will be returned on receipt of a bona fide tender, at the town clerk's offices, Eccles, or at the offices of the consulting engineer, Mr. S. V. Clirehugh, Temple-chambers, Brazenose-street, Manchester. Sealed tenders, which must be on the prescribed form, endorsed "Tender for Electric Lighting," to be delivered to Mr. Geo. Wm. Bailey, town clerk, Town Hall, Eccles, by 12 noon on 30th inst.

Belfast.—Tenders are invited for the supply and erection of two direct-coupled steam-engines and dynamos, battery of accumulators, main switchboard, and installation of about 232 incandescent lamps, complete, for the lighting of Belfast Lunatic Asylum, for the Commissioners for the Control of Lunatic Asylums. Tenders should be sent in a sealed envelope, endorsed outside "Tender for Works for Lighting Purdysburn Asylum," and addressed to the secretary, Board of Control, Custom House, Dublin, and accompanied by a separate sealed envelope, similarly addressed and endorsed, containing the detailed estimate. Forms of tender will be issued on application to the office of the Board of Control of Lunatic Asylums, Custom House, Dublin, on deposit of £1, which will be returned to all persons who have sent in bona fide tenders. Plans and specification can be seen at the office of Mr. O. A. H. M'Cowen, Chapel-lane, Belfast. Tenders by 10 a.m. on 28th inst.

Harrogate.—The Corporation of Harrogate invite tenders for wiring the new Montpellier Baths for electric lighting. Specifications and full particulars may be obtained of Messrs. Baggallay and Bristowe, architects, 66, Conduit-street, London, W., on payment of £1. 1s., returnable on receipt of bona fide tender. Sealed tenders, endorsed "Tender for Wiring New Baths," are to be sent to the town clerk, Municipal Offices, Harrogate, by September 30. The Electric Lighting Committee desire tenders for the supply and erection of the following plant: (Section A) Lancashire boilers, economiser, feed pumps, and accessories; (B) steam alternators, condensers, fittings, etc., steam, exhaust, feed, and sundry pipes, valves, etc.; (C) switchboard and instruments; (F) transformers and accessories; (G) meters; (H) overhead travelling cranes. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for a portion of a section. Specifications may be obtained on application to the borough surveyor, Municipal Offices, Harrogate, on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and endorsed "Tender for Electric Lighting," must be addressed to the town clerk, Municipal Offices, Harrogate, and delivered by September 30.

RESULTS OF TENDERS.

Huddersfield.—The tender of Mr. T. W. Broadbent, Victoria-lane, has been accepted for the lighting by electricity of the boot and shoe and confectionery departments, reading-room, library, etc., in John-street and Albion-street, Huddersfield, for the Huddersfield Industrial Society, Limited. Mr. J. Berry, 9, Queen-street, Huddersfield, was the architect.

Tunbridge Wells.—The following is a list of the tenders received for lighting the Great Hall, Tunbridge Wells:

E. Powell (accepted)	£86	18	0
Electric and General*	80	15	3
Laing, Wharton, and Down	90	15	3
Gilbert and Co.*	107	2	6
Ashby Wood	123	16	9
Hollingum and Saword	131	11	0
Drake and Gorham	168	19	0
S. E. Haward*	176	3	6
J. S. Cunnington and Co.	178	17	3
Tewson and Streatfield	199	7	6
Newton and Co.	198	11	5

The tenders marked thus (*) did not include the price of 120 lamps. The specification for the work was prepared by the consulting engineer to the Great Hall Company, Mr. R. W. Weekes, A.M.I.C.E.

Oldham.—The following were the tenders for wiring the Central Baths, Oldham:

Baxendale and Co., Manchester (accepted)	£32	7	0
Bennett and Druce, Preston	34	0	0
Crossley, Oldham	34	10	0
Day, Oldham	35	0	0
Lomax, Kendal, and Co., Manchester	37	13	6
Waring and Sons, Manchester	42	0	0
Charlesworth and Co., Oldham	43	7	6
Fletcher, Hirst, and Co., Burnley	45	7	6
Paterson and Cooper, London	47	0	0
Corlett Electrical Engineering Company, Wigan	47	10	0
Sansome and Co., Blackpool	53	0	0

West Cowes.—Eleven schemes have been submitted to the District Council for electricity works. The following is a list of the tenders received:

Low-tension, with accumulators.

Electric Construction Company	£5,155
Sharp and Kent	5,333
Bennett and Druce	6,150
Crompton and Co.	6,215
Johnson and Phillips	6,650
John Fowler and Co.	6,970
Greenwood and Batley	7,600
Siemens Bros. and Co.	8,100
India Rubber Company (informal)	—

High tension alternate-current, with transformers.

Brush Company	5,990
John Fowler and Co.	8,350

Mr. Nelson F. Dennis, A.M.I.C.E., the borough engineer, recommends for further consideration the offers of the Electric Construction Company, Sharp and Kent, Crompton and Co.

BUSINESS NOTES.

Julius Harvey and Co., engineers, machinery merchants, and contractors, have opened offices at Mansion House-chambers, 11, Queen Victoria-street, E.C.

Cardiff.—The Corporation have resolved to light the market by arc instead of incandescent lamps. The initial cost will be about £50 more, but a saving will be effected in the lighting of 3s. per hour.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 22nd inst. amounted to £1,239, as compared with £955 in the corresponding week of last year, being an increase of £284.

Stockport.—The Heaton Norris Urban Council have appointed a committee to collect information as to the cost of a system of electric lighting. The committee are empowered to take steps to obtain a provisional order if desirable.

Electrical Trade Organisation.—The electrical supply dealers and contractors of Buffalo, N.Y., have formed an association for mutual benefit and protection, and the placing of the electrical business in that city on a better footing.

Battery and Motor Company, Limited.—Mr. H. T. Barnett has resigned his position as joint managing director in the Battery and Motor Company, Limited, Bower-road, Victoria Park, N.E., and will now act as consulting electrician.

Shoreditch.—Nine tenders were opened at the meeting of the Shoreditch Vestry for insulated electric mains and conductor and drawing-in boxes. The tenders were referred to the Electric Lighting Committee, with instructions to report upon them to the Vestry.

Dover.—A new school of science, art, and technology, which has been erected by the Dover Corporation at a cost of £10,000, adjoins the Municipal Buildings, and is a notable addition to the architecture of the town. The school is lighted throughout with electricity.

Round's Accumulator Company, Limited.—This Company has been registered, with a capital of £10,000 in £1 shares. Object: to enter into an agreement with B. Round and others, and to carry on the business of electricians and electrical engineers, etc., in all or any of its branches.

Aluminium Cycle Fittings Company, Limited.—This Company has been registered, with a capital of £5,000 in £1 shares. Object: to carry on business as manufacturers of and dealers in cycle fittings, and as cycle manufacturers generally. Registered office: 164, Clerkenwell-road, E.C.

Tunbridge Wells.—Mr. Phipps Carey has held a Local Government Board enquiry with reference to the proposal of the Corporation to borrow £12,000 for an extension of the electric light works. Mr. Preece, the consulting electrical engineer, gave evidence, and there was no opposition.

City and South London Railway.—The returns for the week ended September 22 were £831, compared with £835 for the corresponding period of 1894, being a decrease of £4. The total receipts for the half-year 1895 are £10,148, compared with £10,238 for the corresponding period of 1894, being a decrease of £90.

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Edinburgh.—The Town Council have agreed to extend the high-tension electric light system to East London-street by way of Broughton-street at a probable cost of £550. It has been remitted to a committee to consider and report as to the advisability of introducing the electric light in Grassmarket and West Bow.

Southport.—Less than a year ago the Southport Corporation began to furnish private customers with electricity, and to-day (Friday) additional works will be opened with a view to meeting the requirements of a constantly increasing number of customers, and also with a view to lighting the main thoroughfares by means of electricity.

Newquay (Cornwall).—At a statutory meeting of the shareholders in the Newquay Baths and Sanitary Steam Laundry Company, the chairman, Mr. Williams, said that the proposal was to light the buildings by means of the electric light, driven by their own machinery. This, he remarked, was by far the cheapest plan of illumination.

Wimbledon.—The Chairman of the District Council has written to the Local Government Board asking what powers the Council had in the matter of electric lighting, and has not yet received a reply. The London and South-Western Bank, Wimbledon, wrote that when the electric light was installed in the town they would be glad to have their offices lighted with it.

Crystal Electric Lamp Company, Limited.—This Company has been registered, with a capital of £15 000 in £5 shares. Object: to enter into an agreement with J. W. Rogers, and to carry on the business of an electric light company in all its branches. The directors are J. W. Rogers, H J. Gibbs, and F. Naylor. Registered office: St. Stephen's-chambers, Telegraph-street, E C.

Axbridge.—The Highway Board have received a letter from the Telegraphic Extension Office stating that the authorities were about to establish telegraphic communication from Weston-super-Mare to Brean Down Fort, and asking permission to erect the necessary poles on the highway between Oldmixon Bridge and Uphill. Consent was given subject to approval by the surveyor of the position of the poles.

North Staffordshire Tramways.—It is stated that a deputation of about 20 gentlemen, including the mayors of Stoke on-Trent and Longton and representatives of the Hanley and Burslem Town Councils and of other local authorities in the Potteries, have visited Havre to inspect the system of electric traction there, and that preparations are being made to introduce the system over the North Staffordshire tramways which serve the Potteries.

Glasgow.—At a specially-convened meeting of the Home Affairs Committee of the Glasgow Chamber of Commerce, the question of the alleged insufficient telegraphic communication between Glasgow and London was brought up by Mr. Charles Seligmann, and, after discussion, it was unanimously agreed to make strong representation to the Postmaster-General to provide adequate and increased facilities. A memorial to this effect will be at once presented.

New Firm.—Mr. R. F. Venner and Mr. A. Sillar, M.I.E.E., have entered into partnership as representatives of engineering and electrical firms, and will in future act as sole agents for Hookham's electricity meters for the United Kingdom (Birmingham and district excepted) and London agents and sole country agents for the Nalder and Harrison Construction Syndicate. Their London office and showroom is at 10, Delahay-street, Westminster, S.W.

Dublin.—A deputation from the Dublin United Tramways Company has sailed for New York by the "Teutonic" for the purpose of inspecting the newest methods of electric traction in the United States. The deputation consists of Dr. Carte, J.P., chairman of the company; Mr. John R. Wigham, J.P., president, Dublin Chamber of Commerce; Mr. Wm. M. Murphy, J.P., and ex-M.P.; and Mr. Wm. Anderson, J.P., secretary and manager of the company.

City of London Electric Lighting Company, Limited.—Mr. J. Cecil Bull, manager and secretary, writes: "It having been found that the scale set forth in the circular dated January 31, 1895, may be in contravention of Clauses 19 and 20 of 45 and 46 Vic. (cap. 56), it has been cancelled, and the allowances (except the reduction in meter rentals) will not become operative." Mr. Joseph Bevan Braithwaite, jun., has resigned his seat on the board of this company.

Carlisle.—Mr. Dixon said at the last Town Council meeting that in the minutes it was stated that the town clerk had presented a report on an electric lighting provisional order. Were they not going to hear anything about the report? Mr. Forster said that they had got a provisional order, and £430 had been paid for it out of revenue. Mr. Dixon: Don't you intend to go in for it? Mr. Forster: Ultimately. Mr. Creighton said that the matter was only brought up to date. The committee had not yet considered it.

Eastern Telegraph Company.—The directors announce the payment on October 15 next of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum on the preference shares of the Company for the quarter ending September 30, and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income tax, in respect of profits for the quarter ended June 30. The register of transfers will be closed from October 8 to October 15, both days inclusive.

Denbigh.—The Town Council have received an offer from the Edison-Swan Electric Light Company to lease an electric central station and plant for the town and supply light at a rate equivalent to about 4s. per thousand feet of gas if the town would erect the station, which would cost £6,000, on a 30 years' purchase, at the termination of which time the whole system would become the property of the town. The Edison-Swan Company would provide all the plant, engines, etc. The matter has been left to the Lighting Committee to consider.

Enfield.—Mr. Theodore Ellis, of Belcaro, Bycullah-park, Enfield, has written a letter asking for the support of the Urban District Council in the endeavour of an association which is being formed to obtain a provisional order to light the town by electricity. He included in his communication elaborate arguments in favour of electricity. It was decided to send the letter to the General Purposes Committee, and that Mr. Ellis be asked for further details, the Chairman remarking that if they decided to have a refuse destructor they would have to consider whether they ought not to keep the electric lighting in their own hands.

Cutting and Polishing Powder.—We have received a sample of a new cutting and polishing powder—the "Champion." We are informed that it is a Victorian product, entirely devoid of chemicals, and that it can be sold in London at lower prices than emery. It is stated that a quantity was sent to a mill in Melbourne to be ground in an ordinary emery-grinder, when "it was discovered that it ground the machine"; and that it has been tried and adopted by the Victorian Railway Department and by the Melbourne Tramways Company. Mr. F. M Pearson, of 8, Danes-inn, Strand, London, W.C., has been appointed European agent for the material.

Kingswood (Glos.).—The Urban Council have received a letter from Mr. White, on behalf of the tramways company, asking permission for the electric line to be extended down Warmley-hill to where the company had acquired property that they intended to use for car accommodation, etc. It has been resolved to agree to the company's request, provided (1) that they give an undertaking within a given period (not later than one year) to carry passengers on this extra line; (2) to give to the proposed new double line an equal width on each side, as higher up in Kingswood; (3) that they agree to pave the route with wood should the side of the road be paved at any time in that way.

Folkestone.—The Town Council have considered a report from the Special Electric Lighting Committee upon the letter of Mr. Medhurst requesting payment of his account for his report on the electric lighting of the borough, amounting to £55. 18s. 1d. Councillor Baker remarked that the Corporation would have to make application for a provisional order, otherwise a company would do so and take the electric light out of their hands. He thought they did not want to pay Mr. Medhurst till they had made their application. The Mayor said he was afraid that they could not deal with it, and the meeting ended, it being understood that an early meeting of the committee would be called.

Swindon.—The Finance Committee of the Corporation have passed for payment the following accounts in respect of the electric lighting order obtained this year: Messrs. Martin and Leslie, parliamentary agents, £237. 2s. Their total bill amounted to £252. 15s., being £90. 13s charges, and £162. 2s. payments; but they agreed to accept £237. 2s. in settlement. Messrs. Kinneir and Co.'s bill was £99 1s. 6d.; being £94. 4s. charges and £4. 17s. 6d. payments, but they agreed to accept £57. 7s. 6d. in settlement. Mr. Adams, in moving the adoption of this report, remarked that it was very kind of their clerk to make such a reduction in his firm's charges, and also to induce the parliamentary agents to adopt a similar course. The report was adopted.

Bennett and Druce.—Amongst the more recent installations carried out by Messrs. Bennett and Druce, of Preston, are comprised the lighting of eight large sheds at the Salford Docks, the lighting of St. Joseph's Catholic Church (with gas-engine, dynamo, and battery), the lighting of Colonel Ormrod's mansion at Scorton, together with a complete set of cooking and heating apparatus, the fitting of a 15-h.p. electric hoist at the Preston Co-operative Society's warehouse, and the lighting of Messrs. Pyke's corn mills at Preston. The above comprise a total of about 3,000 lights, mostly with engines, dynamos, and storage batteries, and in one case a 15-h.p. boiler, besides numerous smaller installations in various parts of Lancashire. The firm have recently opened a branch office in Belfast.

Leeds.—"It has long been a mystery," a correspondent says, "why the Corporation has not extended the service of the Roundhay electric cars into Briggate. The Roundhay Park line was laid down many years ago at an enormous expense, with the express intention of increasing and cheapening the facilities for getting to the park, and after a long and animated discussion as to the relative merits of overhead railway and tramway. The latter won the day, but after all these years of anxious waiting we are no better off as regards reaching the park cheaply and expeditiously than if the line had never been made, whereas had the Corporation arranged for extending the electric lines into Briggate we should have had a splendid opportunity of judging the merits and defects of the electrical system, and the desirability or otherwise of extending it to the other parts of the city."

Sunderland.—The electric lighting of the Ryhope Lunatic Asylum of the Sunderland Corporation is now completed. About 700 incandescent lamps are employed, supplied by a generating plant consisting of two direct-coupled Belliss engines and Parker dynamos. Steam is furnished by three Lancashire boilers, which also supply the service by means of which the building is warmed. There is also a battery of D.P. accumulators. The laundry machinery is driven by an electromotor, and there are several

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other motors employed for ventilation and for distributing the hot air by which the various wards are heated. Messrs. Edmundsons, Limited, were the contractors for the whole of the electrical installation, while the boilers and heating apparatus were supplied by Messrs. Ashwell and Nesbitt. The electrical installation has been carried out under the superintendence of Mr. G. T. Hine, the architect, and of Mr. A. A. C. Swinton, the consulting engineer.

Derby.—Considerable activity is manifested at the electric lighting installation at Derby, every effort being made to complete the erection of the new coal store and the annexe to the motor-room before winter sets in. Three new boilers, each weighing between 20 and 30 tons, have been ordered, and two of them have already been delivered. It is hoped that they will all three be in working order during the winter. The annexe is being built to make room for a new 250-h.p. motor, which is much needed—the number of consumers having reached 194, whilst several others are waiting to be connected. At present the installation lights over 12,000 incandescent lamps nightly. The demand has for some time exceeded the supply, and it is quite evident that next spring further extensions will be necessary. The demand for current for motors on private premises is rapidly developing. With regard to the finances it is asserted that at the present time—indeed, during the last few months—the undertaking has assumed an increasingly prosperous position, and that even now it more than pays interest on the outlay.

Isle of Man Tramways.—A number of influential Manx capitalists have had under consideration the advisability of constructing a tramway between Douglas and Kirk Braddan. A firm of eminent Glasgow engineers, it is stated, have had a representative at Douglas taking the bearings of the route, and the promoters of the scheme are assured that no engineering difficulty stands in the way of the working of either a cable, electric, or horse tram service. Mr. S. H Emmett, the chairman of the Douglas Head Marine Drive, Limited, has issued a circular to the shareholders announcing the completion of the drive; that the whole of the land is paid for, and that there is cash in hand or owing which will more than pay the company's debts, debenture interest excepted. The directors have arranged for an electric tramway on the drive, and a separate company is being formed to work the tramway. The directors intend to offer Drive shareholders a preferential right of allotment in the new company. The directors point to the Laxey tramway as an instance of the success attending electric traction.

Liverpool.—Application has been made to the Health Committee, on behalf of the Post Office authorities, for permission to erect poles for telephone wires in Pellew-street, Great Newton-street, and Crown street. Mr. Morgan moved that the request be granted. The Government, he said, were expending more than one million pounds in their endeavours to cheapen telephonic communication, and this concession would certainly be to the advantage of Liverpool. Mr. Taggart considered that the wires should be placed underground. Mr. Morgan replied that this would mean a very great increase in the cost. Mr. Taggart remarked that overhead wires were always dangerous. Mr. Morgan pointed to the immunity from accidents hitherto, and said there was no reason to suppose that the danger would be increased in the future. This was simply a temporary arrangement in order to carry out the Act of Parliament passed some years ago. Mr. Menlove, after examining the plan, said he saw that no obstruction of the parapet would be caused. The motion was seconded by Dr. M'Cann, and was carried by five votes to three.

Bath.—Alderman Sturges, at the Urban Sanitary Authority meeting, moved the following resolution, which he explained was only a formal one and in consonance with the one which they passed on January 14: "That the application of the City of Bath Electric Lighting and Engineering Company, Limited, for a provisional order be not consented to, and that the authority apply to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 to 1890, at the earliest possible date." He said that although the course of action which they were to take was settled, the Electric Lighting Acts said that there must be a special resolution passed by the authority after a month's notice had been given. The notice of the resolution which he was to move on that occasion, in corroboration of what he had read, had expired, and he had pleasure in moving that an application be made by the local authority for the district of the city of Bath to the Board of Trade in the next session of Parliament for a provisional order under the Electric Lighting Acts, 1882 and 1888, authorising the said local authority to supply electric energy for public and private purposes within the district of the city of Bath. Mr. Morris seconded, and the motion was carried.

The National Telephone Company Summoned.—At Worship-street Police Court, on Tuesday, the National Telephone Company, Limited, was summoned by the sanitary authority of the parish of Spitalfields for allowing a nuisance to exist on their works, 39, White Lion-street, Spitalfields. Mr. Compton Smith, barrister, defended. Evidence was given by Alfred Cook, sanitary inspector of Whitechapel parish, that in consequence of complaints he enquired into the smells arising from the Company's premises, and found that in a shed at the rear of the premises a process of vulcanising the wires was carried on, and that there was a bath in which melted wax and sulphur were kept at a high temperature. The effluvium arising from the bath was said to be very objectionable. A witness named Wallis and a medical practitioner named Hume gave corroborative testimony as to the objectionable nature of the smells. The defence was that there was nothing in the process to cause offensive effluvia, and residents in the street and officials of the works were called to bear out the contention. Mr. Gripp, M.D., of Gower-street, said that he had been called in to examine and report on the work and could find nothing offensive in the process, but the street "was the most offensive he had ever walked down." Mr. Bushby reserved his decision.

Bolton.—The Chairman of the Board of Guardians has stated that the sub committee appointed to consider the question of lighting the workhouse premises by electricity had met, but were unable to agree. There were four gentlemen present, and two were entirely opposed to the proposal on economic grounds. Mr. Deakin was surprised to hear the result of the committee's work. He understood the majority of the Board were in favour of electric lighting, and moved that it be an instruction to the committee to take steps for that purpose. Mr. Rothwell seconded. Mr. Brocklehurst thought they ought to have had notice on the agenda that the matter was to come before the Board. There was no occasion for undue haste, and a great many members were absent. There ought to be some kind of report furnished by the committee to the Board, and he moved as an amendment that the matter lie over for a fortnight. Mr. Leyland seconded the amendment. Mr. Shaw was in favour of the offices being lighted by electricity. The Chairman said the sole objection to the electric light was on economic grounds. They could not pretend to ask firms to estimate if they had not decided to adopt the electric light. He had some experience in the matter, and it would not cost more than £150. The amendment was eventually carried, Mr. Deakin being prepared to postpone the question.

Aberdeen.—In connection with the forthcoming "at home" at Trinity Hall, the home of the Incorporated Traders of Aberdeen, a meeting of Dr. Guild's managers has taken place, a correspondent says, for the purpose of witnessing the inauguration of the electric lighting of the buildings. The installation, which has been fitted up by Messrs. P. C. Middleton and Co., Schoolhill, Aberdeen, consists of upwards of 150 lights, of from 8 c.p. to 50 c.p., and the result is extremely satisfactory. The fittings are considered to be the finest in the city, and it may be mentioned that the general lighting arrangements have been based on those adopted at Birmingham Town Hall, one of the places visited by the convener, the master of hospital, and other members who composed the deputation that went south some time ago. In the large hall the principal light comes from a very handsome hammered brasswork electrolier of 25 lights, depending from the centre of the ceiling. Near the corners of the ceiling are four smaller electroliers of 10 lights each. Ample light is thus provided, and the decoration of the fine building is seen to the best advantage. The minor hall is illuminated by two electroliers of 10 lights each. The vestibule, staircase, and the various rooms are also brilliantly illuminated, and the effect on the walls and pillars, consisting of six different kinds of marbles, is remarkably fine.

Swansea.—At Tuesday's meeting of the Swansea Town Council there was considered a recommendation that £56,000 be spent on the erection of plant for lighting the town by electricity and for destroying the town refuse. In certain sections a great outcry has been raised on the ground of expense and the inadvisability of going in for the electric light till the light has got nearer to perfection. On this question the Swansea borough surveyor (Mr. Bell), who has considered the question for years, has been interviewed, and he expressed confidence that not only will the scheme pay, but that there will be a profit of a couple of thousand a year after the first three years. There is estimated a revenue of £7,608 from public and private lighting, and against this there is placed the expenditure, including maintenance, capital shares, etc., at £5,798, leaving a balance of £1,810; add to this the £400 saved by the disposal of refuse, and there is £2,210. Sight must not be lost of the fact that unless the Corporation lay down the plant, and that soon, the work will be done by private individuals, who will have the profits instead of the ratepayers. Mr. Bell gives Taunton, Portsmouth, and Brighton as illustrations of the success of the light, where the streets are almost as brilliantly lit at night as daylight. Questioned as to the experience of Cardiff, he said the defects there were due to the engines failing to govern properly. The system recommended for Swansea is that which Mr. Manville thought best—that in use at Portsmouth—the high-tension alternating system, which the Electric Lighting Committee, after careful consideration, also think the best. The Town Council will consider the committee's recommendations at a special meeting on October 1.

Brandon (Durham).—The surveyor (Mr. R. Gardner) has presented to a special meeting of the Brandon and Byshottles Urban District Council a scheme and estimate of cost for lighting the district with oil and gas lamps. The Chairman said that they were not bound to accept the scheme proposed by the surveyor. In that case he thought they might take into consideration the question of lighting by electricity. In the district of Brandon there was a large volume of waste steam at the various collieries, especially at nights and at the week end, and he had an idea that this might be utilised for the generation of electricity for lighting purposes without incurring a single farthing of cost on the owners, and, moreover, he was of opinion that to use surplus steam in this way would relieve the strain on the boilers which ensued through the excessive heat from the coke-ovens, which, as most of them knew, supplied heat for steam-making. If the colliery owners would meet them in this matter, he felt assured that they would not only benefit the community, but further an arrangement of considerable value to themselves. Mr. J. J. Lishman did not think the colliery companies would supply steam, as suggested, for nothing. Eventually the following resolution was unanimously adopted: "That the Corlett Electrical Engineering Company, of Newcastle, be requested,

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under the instructions of the chairman and surveyor, to report upon and estimate for the lighting by electricity the main roads and streets of the Council's district." A further resolution, that each of the several wards in the district call upon the colliery owners in their wards and ascertain how far they would assist the Council in the matter of lighting the district with electric light, was also carried unanimously.

Wandsworth, S.W.—The District Board of Works have considered a letter from the Brush Electrical Engineering Company, with reference to repairing trenches after the laying of electric light mains in this district, and recommended that the company be informed, in reply, that the paving disturbed by them will be made good by the Board promptly upon the trenches being filled in. The Wandsworth Committee recommend that the plan of the proposed electric light generating station at the Causeway, and of the works in connection therewith, be approved subject to an agreement satisfactory to the committee being entered into between the Board and the electric lighting company, with regard to the use of the proposed way by the Board for vehicular traffic to the Feathers Wharf upon payment by the Board of one-sixth of the cost of repairing such way, the provision for outfalls on the river, etc.; that the plan of the proposed drain from the generating station to the sewer be approved, subject to the right of the Board to connect a drain from the Feathers Wharf to the proposed drain without charge; and that the Board do all in their power to assist the company in obtaining the consent of the London County Council to the plan, and the consent of the Wandsworth Vestry to the proposed diversion of the Causeway. With reference to the letter from the Royal Wandsworth Laundry stating that the stopping up by the electric lighting company of the flow of the mill stream near their premises at Bell-lane causes a greater quantity of water to pass through the creek, and enquiring whether the Board have taken into consideration the possibility of their premises being flooded in the event of very high tides and heavy rains—that they be informed that the Board have no power to interfere in the matter, and that they be referred to the electric lighting company.

Killarney.—The recent audit of the Town Commissioners' accounts by Mr. J. Calvert, public auditor, raised the important point whether a corporation could keep going two systems of lighting—gas and electricity—at the same time. Mr. Moriarty, who appeared for the Commissioners, contended that it was competent to the Commissioners to try the two systems of lighting in the same way the London or any other corporation did when a new light, as the electric light was, came in. Killarney was a tourist route, and not merely a town of 5,000 inhabitants situate in a remote district, and it was therefore fairly entitled to a greater degree of light. There was nothing to prevent the Commissioners from trying both the gas and the electric lights, and he asked that before the auditor decided on surcharging he should hear some evidence on that. The Auditor said the first question he would decide was: Was it in the interest of the ratepayers to have both lights? He was perfectly clear from his own knowledge and observations that one light was necessary for the town. After some discussion on the legal validity of the contracts with the gas and electric lighting companies, the Auditor announced that he would give his decision in six weeks.—The Governors of the District Lunatic Asylum have passed the following resolution: "That we request the Board of Control to accept Messrs. Ferguson and Co.'s tender (£957) for the installation of the electric light in the asylum, if they give satisfactory security for the performance of their contract, but that before accepting any tender we request the Board of Control to furnish us with a copy of the contract to be entered into with the Killarney Electric Light Company for the supplying of the electric current." The Board of Control forwarded 20 tenders received by them for the installation of the electric light. They varied from £3,195 to £957. The consideration of them was deferred until Mr. Leake, the electrical engineer, was in attendance.

Sheffield.—A correspondent writes: At the Empire Palace of Varieties, which is rapidly approaching completion in Pinstone-street, the electric lighting company are busily engaged in wiring the building for the supply of the Palace, which is to be lighted throughout by electricity. The light will be controlled from a switchboard on the stage. The sunlight will be formed by 20 lamp pendants from the rim of the circular sliding roof, all festooned together, giving a light equal to 640 candles. The intermediate portion of the ceiling will be lighted by 10 ceiling lamps, giving a light of 320 candles, and the remaining portion of the ceiling by 10 three-light brackets, projecting from 10 ornamental shells, and giving a light of 480 candles. The decorative fronts of the dress and upper circles will be lighted by ornamental three and two light brackets, giving a light of 480 candles. The whole of the above light can be raised to full brilliancy or lowered, as required for stage effects. The entrances staircases, lounges, smokerooms, corridors, offices, etc., are lighted by a variety of pendants and brackets of an ornamental character, representing light of something like 3,200 candles. The shelter over the pavement in Upper Charles-street and Union-street will also be lighted, and above these will be suspended six arc lamps of 2,000 c.p. each. The stage will be illuminated by four suspended battens, each containing lamps, giving a light equal to 1,280 candles, proscenium and footlights equal to 2,000 candles, making a total light of 7,520 candles on the stage. The whole of the stage lights are arranged to give white, red, and green lights, and all can be lowered for stage effects. Stage arc lamps will be used, similar to those in use in most of the London theatres, instead of limelight. The work is in the hands of the Sheffield Electric Light and Power Company, Limited, under the personal supervision of Mr. A. Lucas and Mr. C. Furness, and similar lines have been followed to those found so successful at the Alexandra Theatre, which work was also executed by this company.

Hastings.—The following communication has been addressed to a local paper: "We saw in the report of the Hastings Gas Company, published in your issue of the 7th inst., that Dr. Gray is said to have stated that for electricity to compare favourably with gas it must be reduced in price to 3d. per unit. Although we have never actually tested the light-giving properties of Hastings gas as compared with electric light, we had always understood, from experiments that had been made in other towns, that with gas at 3s. per 1 000 cubic feet, and electric light at 6d. per unit, the total cost for a given amount of light would be practically the same. In order to see which of these statements was correct, we have had fitted up at the works seven Bray gas-burners on one side of a room, and a 200-c.p. Ediswan electric lamp on the other side. By means of a Bunsen grease-spot photometer the light was adjusted until it was equal from each source. These were left burning for two hours, from 9 p.m. to 11 p.m., and careful measurements taken of the gas and electricity consumed. It was found that 142·2 cubic feet of gas had been used; this, at 3s. per 1,000 cubic feet, is about 5d., whereas the electricity meter showed that only ·76 unit had been used. In order to bring the total cost up to the same as that of the gas it will be necessary to reckon the electricity at 6½d. per unit instead of 3d., as stated in the gas report. Dr. Gray will be interested to know that several of our customers will not pay on an average more than 6d. per unit for their current used during this half-year, whereas many, profiting by our new system of charging, are replacing gas lamps with electric lamps, for which they will not pay more than 4d. per unit for the current used. From this it is obvious that in many cases it will be necessary for the gas company to further reduce the price of gas to 2s. per 1,000 cubic feet before they can compare favourably with the present price of electricity. We shall be pleased to repeat the above experiments in the presence of Dr. Gray or any others whom they may interest.—L. ANDREWS, managing engineer to the Hastings Electric Light Company."

Llanelly.—The clerk read the following letter at the meeting of the Borough Council: "New Dock, Llanelly, September 9, 1895.—Dear Sir,—We should be glad to know whether your Council would be prepared to dispose of their provisional order for lighting Llanelly, and if so, on what terms? You are, of course, aware that we have given notice that we intend applying for a provisional order ourselves, but it might suit our purpose equally as well, and, since you have now declared your intention not to proceed with your own order, suit you also, if we were to acquire your order.—Waiting your reply, we remain, yours faithfully, J. C. Howell Limited." The Clerk explained that on the receipt of that letter he had written to Messrs Howell asking what they would be prepared to offer. He received a reply to the effect that they would prefer knowing the terms of the Council. The Chairman asked what were the terms of the provisional order. The Clerk explained that the order would not expire until it was rescinded by the Board of Trade. The Council, according to it, were supposed to light the town before the expiration of a certain period. But this order was not like an ordinary Act of Parliament, and they were not bound to carry out its provisions. The Chairman said the question was whether they would hand over the powers to private enterprise. They must not act upon the dog-in-the-manger policy. Mr. Maybery did not see much objection to disposing of the order. The Clerk, in reply to a question, said that the order cost the Council a sum of £223. Mr. Guest: Would it be worth asking that for it? The Clerk said that supposing Messrs. Howell applied for a provisional order, and the Council opposed it, what would be their position? Providing there was no opposition, it would cost them about £250 to get. Mr. Guest asked if in selling the order they could not keep a few of the clauses to themselves? Mr. Thomas wanted to know if the Council could part with the order, and dispose of it to a private company? The Clerk said they could grant a license, subject to the consent of the Board of Trade. It was ultimately decided that the clerk should report upon the matter at the next meeting.

Worksop.—The following letter has been forwarded to the chairman and councillors of the Worksop Urban District Council, Worksop, Notts.: "Gentleman,—As an engineer who has taken up residence in Worksop within the last year or so, on account of the town being a more healthy and pleasant neighbourhood than Sheffield, it has seemed very clear to me that there is considerable room for improvement in the appearances and conveniences of our town. I, with several others, am of opinion that what we require first is light—more light—and, if possible, cheaper light, and with this in view I am attempting to form an electric light and power company here. With this end in view, I have acquired a very suitable piece of land in Bridge-place (opposite the cattle market) from Sir Henry Watson upon most reasonable terms, which I am prepared to transfer to the proposed company without profit. I hope this scheme will meet with the approval of your Council, and will be encouraged by you, so far as lies in your power. I may say that I have two schemes whereby the electric current can be used as power, with a good profit, and shall be able to guarantee that nothing will be done in connection with the company's works that will be in any way offensive to the neighbourhood. In the first place, I anticipate that the current will be taken up by manufacturers, hotel and shop keepers, and householders, who are anxious to preserve their wares, house fittings, and decorations from the ill-effects of burning coal-gas. In the second place, I have good evidence that the railway company will take the current to light the Worksop goods and passenger stations when I can show them

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that a substantial company has been formed. The Council will at once see the advantage it will be to Worksop to have a well-lighted railway station and approach thereto. In the third place, I anticipate that your Council will be pleased to take the current for lighting the Town Hall and principal thoroughfares, as I believe they will be well supported by the Worksop people in doing so. The advantage of having your assembly-room in the Town Hall lighted up by electricity for public and recreation meetings cannot be overrated, and the lighting of the main thoroughfares from the railway station to the Worksop Manor gates by the current will well deserve the consideration of the Council. Your approval of the scheme will, I feel sure, be favourably greeted by the inhabitants of Worksop and district.—Yours, etc., THOMAS NASH."

Hampstead.—The Lighting Committee reported at the last Vestry meeting that they had empowered the vestry clerk to take all necessary proceedings against the London and Hampstead Battery Company for non-compliance with the by-laws made by the London County Council under the London Overhead Wires Act with reference to the wires placed by them over and along the public streets in this parish. A letter was received from the solicitor of the Vestry reporting the result of a summons against the company, stating that the company admitted they were in default, and that upon payment of the costs, the summons was withdrawn, the Battery Company undertaking to comply with the by-laws within seven days. The Lighting Committee reported that they had empowered the engineer to order another plant, similar to the large unit at present in the station, at the estimated cost of £2,343, such sum including all expenses in relation to erecting the same in the station ready for actual use. The report was approved. The action of the same committee in empowering the engineer to order certain materials, etc., required was also approved. Amongst the articles were a number of house-service boxes at 35s. each. Mr. Johnson asked what price had been formerly paid for house-service boxes The Electrical Engineer: £3 16s. each, but they were not the same boxes as these. Mr. Colley explained that these cheaper boxes were to be tried as an experiment. The same commitee reported that they had given instructions that in the future no pupils or improvers would be allowed to be taken on at the station.—Approved. The same committee also reported that they had given instructions for the whole of the staff employed by the Vestry in their electric lighting undertaking to be insured in the Boiler Insurance and Steam Power Company, Limited, at the rate of 5s. per cent. on the annual wages paid, such rate including injuries arising from electric shock.—Approved. Instructions were given for an electric motor to be obtained for the chaff-cutting machine at the stone-yard, from the General Electric Company, at a cost of £24. 3s. 9d. On the motion of Major-General Young, it was decided to obtain and fix a Blackman electrical ventilator in the Board-room of the Vestry Hall. A letter was received from Mr. W. H. Preece, submitting his account for balance of commission for professional services rendered to the Vestry in connection with the electric light installation, amounting to £1,353. 18s. 6d. It was referred to the Finance Committee.

Bedford.—The Electric Light Committee of the Bedford Town Council have reported—(*a*) That the sanction of the Local Government Board has been given to borrow the further sum of £27,000 for electric lighting purposes, such sum to be repaid within a period of 25 years from the date of borrowing the same. (*b*) That acting upon the instructions of the authority they have given notice to the Bedford Gaslight Company, informing them that after February 6 next they will discontinue the use of the lamps in 67 public streets (*c*) That a communication has been received from the Bedford Gaslight Company, drawing attention to the system adopted in the extension scheme of laying the cables in stoneware culverts instead of in iron pipes. The committee, whilst fully appreciating the kindness of the company in drawing attention to the fact in the interest and safety of the public, would observe that the Council can with safety adopt the system of stoneware culverts. The system is now in use in Westminster, Edinburgh, Manchester, Sunderland, Bradford, and many other places, and the result is in every way satisfactory. (*d*) That they have much pleasure in stating that the demand for electric light is increasing. The committee recommend (*e*) that the engineer be empowered to procure iron pipes and cables for the high-tension mains to St. Mary's sub-station, and the remainder of the cables for the following streets—viz., Tavistock-street (to Adelaide-square), St. Peter's-street, St. Loyes-street, Harpur-street, Newnham-road, St. John's-street, St. Mary's-street, Cardington-road, and Cauldwell-street—and also the necessary switches, fuses, ammeters, and voltmeters for the station, and two additional transformers and fuse-boxes for the sub-stations. "The electric lighting in Bedford," says a Bedford contemporary, "has so far been very successful, and the promise of still greater success in the future is very encouraging. Early next year a great many of the streets will be lit by electricity instead of gas, and the cost will in time be defrayed out of the profits derived from the electricity supplied to private consumers. A great deal used to be said about taxing the inhabitants of back streets for the illumination of the main streets, on the supposition, we presume, that only the larger streets would be lit by electricity. Even if that supposition had been correct, the inference drawn from it would be incorrect, inasmuch as the dwellers in the back streets make as much use of the main streets as do other inhabitants of the town. The jealous criticism of the doings of the Electric Lighting Committee by persons who opposed the undertaking by the Corporation is not to be regretted. It will keep the committee up to the mark, and will be the means of frequently eliciting facts which will but the more completely justify the action of the Council."

Bristol.—With reference to the outbreak of fire in a transformer-chamber in connection with the electric light in St. James's, Barton, on Monday evening, it appears that the incident was quite an isolated one, and entirely connected with an experimental test. A *Bristol Mercury* reporter sought an interview with Mr. Faraday Proctor, the electrical engineer, to enquire the exact cause of the accident. He learned that the engineers were testing the new cables for the Stoke's Croft supply at three times their working pressure before permanently joining them up to the Stokes's Croft service, for which a cable runs into St. James's, Barton, transformer-chamber and then on again to the next sub-station at the bottom of Thomas-street, Stoke's Croft. For the testing purpose temporary wires were laid across the sub station from one end of this cable to the other to convey this extreme pressure, and as it was thought possible there might be some breakdown under such an extra current, the covers of the chamber were left off, and a man was left to watch while the pressure was on, and with directions to telephone to the central electric station if anything went amiss. Directly the pressure was got up at the works on Temple Back the small fuses there burnt out, and the foreman was immediately sent to the Barton sub-station. At the same time a telephone message was received that smoke was issuing from the manhole of the transformer-chamber. The temporary wires were fastened to some small pieces of creosoted wood, which also caught fire. These pieces of wood were for the purposes of fixing the wires, and, although there was a great volume of smoke, the engineers state that there was really no great body of fire, as there was little there to burn, and incandescent lamps burning there at the time of the occurrence had remained intact. The supply in Stoke's Croft, having been cut off for the afternoon for the purpose of joining up certain premises taking the light, could not be restarted until the men could get into the Barton sub-station. But after the fire the current was again turned on at seven o'clock at full power. There was a thin roof of match-boarding over the chamber for the purpose of fastening the cables, but the whole structural portion of the building is made up of Cattybrook brick walls 2ft. thick, concrete floors, and the floors or roofs 2ft. thick, and concrete and iron girder work. In addition there was a thin sheet of lead immediately covering the match-boarding, with the object of letting off any water which might leak through the concrete. Substantially, all the contents were fireproof with the exception of the match-boarding and the small pieces of wood already described. Thus there was nothing but this wooden portion to burn in Monday's mishap, and within half-an-hour the electrical engineer was enabled to descend into the chamber and inspect it. He found that the temporary wires together with the pieces of wood and match-boarding, were burnt away, but the two transformers and the high-tension boards and other apparatus were safe and intact, and the whole damage would be covered by a few pounds. Thus the local paper. Mr. Faraday Proctor informs us, by letter, that they have never had any explosion or suspicion of gas in any of their chambers, and that the new cables referred to (in Stoke's Croft) were tested to 6,000 volts on Wednesday morning, and found perfectly satisfactory.

Brighton.—A correspondent writes: The latest, and, from the point of view of the general public, most practical and interesting development of the Brighton Corporation electricity undertaking—namely, the illumination of the principal thoroughfares of the town by the arc system—is beginning to assume form and substance. For some weeks past the work of erecting the standards for the lamps has been in progress, and in all probability the new installation will be inaugurated in detail during November. When complete the installation will consist of 120 lamps, about 50 of the standards being similar in design to those on the King's-road for use along the Marine-parade chiefly, and the remaining 70 of the bracket pattern. These standards are according to designs prepared by Mr. May, the borough engineer and surveyor. The installation will extend the whole length of the Western-road, North-street and St James's-street, Queen's-road and West-street, Preston-street, East-street, the Old Steine Marlborough-place, and the London road to New England road. The lighting of the Marine-parade will also complete the line of lamps along the sea front, and two lamps will likewise be put up in Ship-street. Of the thoroughfares named, the Western-road, Queen's-road, and West street have been dealt with so far as relates to the somewhat obstructive work of setting up the standards, and North street and the Marine parade are now engaging attention. This application of electric light to public purposes within the town will necessarily add materially to the business and to the prosperity of the electricity undertaking; but really the progress of that undertaking has exceeded even the most sanguine anticipations of the strongest advocates of this addition to the responsibilities of the Corporation. Acting under the advice of their able manager, Mr. Wright, the Lighting Committee some time since introduced a differential rate, based on the hours of consumption, the effect of which in Brighton has been to reduce the average charge for the light to about 4¾d. per unit, a rate lower than that charged in any other town, with the exception of Manchester, notwithstanding that the cost of coal is greater in Brighton than elsewhere. Imitation being the sincerest form of flattery, it is worth making a note of that this differential rate, known as the Brighton system, has been adopted at Bournemouth, Southport, Hastings, Blackburn, Coventry, and in other towns, Manchester having it also with modifications. The increase in the number of customers has

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been from 157 in 1892 to 336 in 1893; 720 in 1894 to 970 for the year ended the 16th inst. Moreover, while in other towns the yearly supply of electricity has never exceeded three units per inhabitant, in Brighton in 1894 it was five units, and during the year just closed it was 10 units. The profit made last year was £9,800, or with the balance in hand £10,100, of which amount £5,014 was appropriated for the loan account out of which will eventually come the redemption of the undertaking which will remain a handsome legacy to posterity. The Lighting Committee of the Corporation have had before them a letter from Mr. J. V. Witting enquiring the terms for laying a supply of electricity to Hollingbury Copse, Ditchling road, Patcham, but the premises being outside the borough they resolved that they were unable to supply them with electricity. It was decided that a main be laid in Bedford-square, and that another be laid from Western-road as far south as Sillwood-road.

St. Pancras.—Messrs. Hancock and Dykes, of 5, Victoria-street, London, S.W., have addressed the following communication to the *Times*: "Within the last few days an innovation in the supply of electricity has been quietly introduced which may have a very marked effect on the future of electric lighting. The Vestry of St. Pancras have doubled the pressure at which they supply the current, and, although probably all supply companies will ultimately do the same, one is entitled to protest against the suddenness of the change in this case, as it is certainly prejudicial to the public interest. Very few of the manufacturers and others interested have been properly advised, and as there has so far been no demand for 220-volt fittings and appliances there are none on the market. Until a sufficient time has elapsed for suitable fittings to be designed and produced there will be a very grave risk of extinction, damage, and perhaps fire, on 220-volt circuits. As far as the lamps are concerned, 8-c.p can no longer be used; the 16-c.p. is the smallest size obtainable, and that is expensive, ugly, and altogether untried in performance. Time alone will enable the makers to perfect and produce what is required, and surely the authorities are not warranted in increasing the capacity of their mains, when in order to do so they sacrifice the public convenience, and perhaps safety, by not giving ample notice of their intention to make so radical a change." To this Mr. Sydney W. Baynes, chief engineer, St. Pancras Vestry Hall, N.W., has replied: "Had your correspondents applied to me at the Vestry Hall for information on this matter it would have been to their advantage, as they are evidently very far from being up to date regarding high-voltage lamps and fittings. It may interest them to know that I have had such lamps in constant use for 18 months, and for the past seven months they have been installed in the premises of customers supplied from one of the most prominent and successful stations in the country, with excellent results. No alterations in the fittings or wiring have been needed. The ordinary tumbler switch, good porcelain cut-outs, well-insulated wire, combined with good workmanship, have long since proved thoroughly efficient and safe in carrying even a still higher voltage than that to be introduced at St. Pancas. Eight-candle-power lamps at 230 volts are in the market, and Mr. Stearn the joint inventor with Mr. Swan of the incandescent lamp, is to the front with a high-voltage lamp of 6 c.p. Your correspondents could never have seen a properly-constructed 220 volt lamp, or they would not have stigmatised it as ugly, seeing that the best makers turn out a lamp in no outward respect different from the 110-volt lamp, which, like the original 50-volt, will in time become a matter of ancient history. Those who best understand the subject and its importance on the future of electric lighting are the most desirous of co-operating to render the movement I have introduced thoroughly popular and successful" Messrs. Hancock and Dykes replied on September 25: "We note Mr. Baynes's letter in your issue of to-day, which interests us, as we applied to certain well-known lampmakers and also manufacturers of fittings only a week ago, and they were no more up-to-date than we are. Surely it is scarcely right for a public body like the St. Pancras Vestry to recommend certain makers before other equally important ones have even been advised of their requirements. It should be added that our thirst for knowledge led us to make enquiries at the Vestry's Stanhope-street electric light station; but Mr. Baynes has evidently kept all these good things to himself, as the officials there surprised us by asking for the very information which we had come to seek. Our previous letter makes it tolerably clear that we also wish to see the movement succeed, but do not agree with the method of initiation. From our past experience with 220-volt installations we believe it to be the voltage of the future, but beg to repeat that in our opinion much of the existing wiring is unsafe at that pressure. With reference to the performance of the lamps, a trial will easily settle the question. If Mr. Baynes will choose 12 8-c.p. or 16 c.p. 220-volt lamps, we will also select an equal number of 100-volt lamps, these to be submitted to an independent expert for a comparative test as to life at a steady voltage and also with a voltage fluctuating 4 per cent. above and 4 per cent. below the normal, both sets of lamps to have an efficiency of 3·75 watts per British candle-power. We trust that Mr. Baynes will accept this challenge, as it will at once set the question at rest."

Nottingham.—In celebration of the anniversary of the installation of the electric light in Nottingham, an interesting function has taken place at the electric lighting station in Talbot-street. Invitations had been issued by Alderman Sir Jno. Turney to the members of the Electric Lighting Committee, the chairman of the Gas Committee (Alderman J. Barber, J.P.), and the officials of the Corporation to meet him at the works and inspect the machinery in operation. In response to the invitation, there were present: the Mayor (Councillor J. Bright), the sheriff (Councillor Dr. F. R. Mutch), Alderman J. Renals, J.P., Alderman F. Pullman, J P., Alderman S. H. Sands, J.P., Alderman J. Barber, J.P., Councillors R. Fitzhugh, J.P., J. T. McCraith, J.P., and W. Bailey the town clerk (Sir S G. Johnson), the borough engineer (Mr. A Brown), the electrical engineer (Mr. H. Talbot), the borough gas engineer (Mr. W. R Chester), the deputy town clerk (Mr. J H. Richards), the assistant borough engineer (Mr. T. B. Lewis). and the assistant borough accountant (Mr J. E. Bryan) Under the guidance of Mr. Talbot the visitors spent a pleasant half-hour in the examination of the works, which were pronounced to be in the most satisfactory condition. Alderman Sir John Turney said he thought it would be well some time ago to give gentlemen of the Council an opportunity of meeting the Lighting Committee. They would remember that when the station was finished there was no flourish of trumpets or opening ceremony. The committee felt that having undertaken this work, and it being a new venture, they had better run the work for a considerable time before they expressed an opinion about its value and its efficiency. Of course he had taken a great interest in electrical work from a general point of view for many years, and when the Council decided to appoint a committee to take seriously into consideration the supply of electric current for the people of the town, that committee devoted a considerable amount of time to visiting the various stations of the country with a view to arriving at what they thought would be the best plant to lay down. After doing that, and taking the advice of eminent electricians and engineers they decided to adopt what was known as the direct-current three-wire system. On that plan they had based their installation, and they believed that in doing that they had adopted the best plan, although in the neighbouring towns of Derby and Leicester there was an opposite condition of things—namely, the alternating system. The committee claimed that their system had advantages over the others. They could run their plant practically with one shift instead of having a double shift. They could give a continuous supply of current without being at the mercy of movable machinery. However perfect movable machinery might be, it was at times an unknown quantity, and when they were most relying upon it it failed them. Their engines were directly coupled with the shaft of the dynamo They had no large horizontal engines such as worked the alternating system. Their site as was well known, was very limited, and therefore they had to take that fact into consideration. Their engines were giving them about 640 h p The committee felt that in establishing the plant on the lines they had established it, and before talking about its efficiency having a year's working before them they had pursued a wise policy. They were justified in the course they had taken by the 12 months' working. He had figures before him which he thought would compare favourably with, or would be equal to, those of any electrical station, whether established by a corporation or a limited company so far as actual cost went. The total amount of capital they had invested in this undertaking at the present time was £48 633, which was divided in the following way: cost of site of station, £10 823; the building had cost £11,200; the machinery cost £10 286; the accumulators which they had just seen cost £1,421; the mains in the compulsory area which the Corporation decided to light cost £10,094, and since then they had to spend on extensions outside the compulsory area £3,751, and the meters had cost £911, and the electrical instruments, £147—making, as he had stated, a total of £48,633. The revenue account showed the following figures: Sale of current for three completed quarters—Christmas, 1894, £742. 1s. 3d; Lady Day, 1895, £854 14s. 10d.; Midsummer, 1895, £413. 8s. 8d.; a total of £2,010. 4s. 9d. Other receipts amounted to £80. 14s., the total revenue for nine months being £2,090. 18s. 9d. The total cost of generation was £1,383. 16s 4d., and the gross profit £707. 2s. 5d. The machinery had been built by the best makers, and had been put in under the supervision of the electrical engineer, Mr. Talbot, who was a most careful and painstaking man. There was no doubt that if they had had another winter quarter they would have been able to show better results, but, treating the concern as an ordinary company, they were able to show a profit of 2 per cent. on the undertaking. The number of consumers who had applied for current at the time the station was opened in September, 1894, was 35, but the number of consumers on the books at the present time was 148 He had not the slightest doubt that the results of another year's working would show greater profits on the outlay. They had to day over 12 miles of cable laid down in the town. This represented 12 months' work. They would doubtless have many more miles laid during the next 12 months. The Mayor said they had been greatly interested in the information imparted by Sir John Turney. He ventured to think that the Corporation adopted a very wise policy in waiting in order that they might gain the experience of other towns in the matter of electric lighting, or rather in the manner in which the electric light might be produced, and supplied in the most perfect style and most economical way. He believed the policy of delay was one which would be fraught with the greatest possible interest to the town. In his opinion it had also been wise on their part that, instead of handing over the supply of electric light to other individuals—to a limited company—the Corporation had retained the supply of electric lighting in their own hands. They complimented Sir John Turney upon the success of the enterprise so far as it had gone. When the buildings were completed it was contemplated presenting him with a gold key with which to open them. But since there had been no formal opening he had now very great pleasure in asking Sir John's acceptance of the key as a memento of the great work in which he had been engaged. Alderman Sir John Turney, in accepting the gift, expressed the pleasure which the work connected with

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the committee had afforded him, and observed that if they were to keep pace with the times they ought to have electric tramways in Nottingham.

PROVISIONAL PATENTS, 1895.

SEPTEMBER 16.

17232. **An automatic and electrical tell-tale apparatus for indicating water and other liquid levels.** James Dixon, 209, City-road, London.

17249. **An improved gauge for gauging electrical and other wires, drills, boring bits, and other similar articles.** Albert Ernest Woodhouse, 7, Staple-inn, London (Complete specification.)

SEPTEMBER 17.

17283. **A method or system of utilising town's water for generating electricity.** Edgar Booth, Commercial-street, Halifax

17287. **Improvements in and relating to insulators for telegraph and telephone poles.** William Dibb and Albert Vickers, 17, St. Ann's square, Manchester. (Complete specification.)

17288. **Improvements in and connected with the electrolytic decomposition of alkaline salts.** William Adolph Rosenbaum, 70, Market-street, Manchester. (Complete specification)

17290. **An adjustable support for electric lamps or similar fixtures.** George Davis, 4, St. Ann's square, Manchester. (Otis Converse White, United States.) (Complete specification)

17296. **Improvements in ships' or navigable vessels' mechanical telegraphs.** Albert Edward Seaton and William Henry Willatt, Wilton House, Holderness-road, Hull.

17328. **Improvements in electrical attachments for playing pianos.** George Houlett Davis 45, Southampton buildings, Chancery-lane, London. (Complete specification)

17330. **Improvements in electric exploders** Herbert Vivian Keeson, 40, Loudoun-road, St. John's Wood, London.

17365. **Improvements in and relating to automobile cars for electric railways.** Reginald Belfield, 31, High Holborn, London.

SEPTEMBER 18.

17400. **Improvements relating to permanent way, electric conduits, and conductors of electric tramways.** John Thomas Wood and John Alexander Brodie, 26, Castle-street, Liverpool.

17430. **Improved methods of and means for making and breaking electric circuits.** Reginald Belfield, 31, High Holborn, London.

17436. **Improvements in thermo-electrical generators and the method of operating same.** Harry Barringer Cox, 46, Lincoln's-inn-fields, London (Complete specification)

17442. **Improvements in electric resistances.** Leicester Bradney Stevens, 40, Chancery lane, London. (Complete specification.)

SEPTEMBER 19.

17479. **An improvement in connection with electric pushes for hall or other doors which may be used in connection with or replace existing door-knobs, handles, or pushes.** C. P. J. Fitzsimon, 1, George's-avenue, Clonliffe-road, Drumcondra, co. Dublin.

17481. **Improvements in electrollers.** Robert Hall Best, 18, Southampton-buildings, Chancery-lane, London.

17495. **Electrical heating apparatus.** Victor Isidore Feeny, 60, Queen Victoria-street, London. (H. W. Johns Manufacturing Company, United States.) Complete specification.)

17505. **Improvements in electrodes.** Carl Hoepfner, 45, Southampton-buildings, Chancery-lane, London.

17507. **Improvements in and relating to electric cables.** Jean Graizier, 45, Southampton-buildings, Chancery-lane, London.

17510. **Improvements in electric current meters.** Robert Hacking and George Brand, 78, Fleet-street, London.

17525. **Improvements in the electrolytical manufacture of bleaching liquid.** Carl Kellner, 46, Lincoln's inn fields, London

17526. **Improvements in electrical transformers.** Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

17528. **A new and improved electro-deposition, more especially applicable to electro-plating.** Alfred Francis Bilderbeck Gomess, 9, Warwick-court, Gray's-inn, London.

17529. **Improvements in arc lamps and in stands therefor.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Edward Powell Hopkins, United States.)

SEPTEMBER 20.

17603. **Improvements in electric batteries.** Michael Martin Bair, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

17573. **Improvements in electrolysis.** Graydon Poore, 9, Quality-court, Chancery-lane, London.

SEPTEMBER 21.

17634. **Improvements in and relating to incandescent electric lamps.** William Henry Soulby, 2, Old Market-chambers, Yorkshire-street, Rochdale.

17655 **Improvements in secondary batteries.** Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster.

17656. **Improvements in spring contact switches.** Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster.

SPECIFICATIONS PUBLISHED.

1887.

4225.** **Electricity meters, etc.** Hookham. (Amended specification.)

1892.

15887 **Obtaining metals by electrolysis.** Frei. (Second edition.)

16300. **Supplying electricity to carbon electrodes.** Frei. (Second edition.)

1893.

10298. **Dynamo-electric machines.** Sayers (Second edition.)

1894.

14765 **Electrically reproducing graphic matter or designs.** Williams

18501. **Incandescent electric lamps.** Ker.

20397. **Arc lamps.** Creffield.

21142. **Electromotors.** Siemen Bros. and Co, Limited. (Siemens and Halske.)

21827. **Dynamo-electric generators.** Imray. (Société Anonyme pour la Transmission de la force par l'electricité.)

24934 **Electric switch.** Wagg.

1895.

57. **Ascertaining difference of electrical potential.** Hopkinson.

3548. **Electric switch.** Edge.

13434. **Electrolytical production of zinc.** Siemens Bros. and Co, Limited. (Siemens and Halske)

14481. **Imitation candles for electric lights.** Poole and Lowry.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	—
Brush Company, Ordinary	3	1¼-1⅜
—— Nom. Cum, 6 per cent. Pref.	2	1⅛-2⅛
—— 4½ per cent. Debenture Stock	100	111-114
Charing Cross and Strand	5	5⅛-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	5	7-7½
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	13½-14½
—— 6 per cent. Cumulative Pref.	10	14½-15½
—— 5 per cent. Debenture Stock	100	133-137
City and South London Railway, Consolidated Ordinary	100	38-40
—— 4 per cent. Debenture Stock	100	134-136
—— 5 per cent. Pref. Shares	10	14½-15½
County of London and Brush Provincial Co., Ordinary	10	8¼-9¼
—— 6 per cent. Cum. Pref.	4	6½-7½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1-2
Edis n and Swan United Ordinary	3	2-2½
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅝-¾
—— 6 per cent. Debentures	—	—
—— 7 per cent. Cumulative Pref.	2	2⅛-2½
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	¾-1⅛
Fowler-Waring Cables	5	1-1⅜
W. T. Henley's Telegraph Works, Ordinary	10	12½-13
—— 7 per cent. Preference	10	15-16
—— 4½ per cent. Debentures	100	104-107
House-to-House Company, Ordinary	5	—
—— 7 per cent. Preference	5	—
India Rubber and Gutta Percha Works	10	19-21
—— 4½ per cent. Debentures	100	102-104
Kensington and Knightsbridge Ordinary	5	—
—— 6 per cent. Pref.	5	—
Liverpool Electric Supply, Ordinary	5	7⅛-8⅛
Liverpool Overhead Railway	10	11⅛-11⅞
—— 5 per cent. Pref.	10	15-15½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
Metropolitan Electric Supply	10	12-12½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-119
National Telephone, Ordinary	5	6⅛-6⅜
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Non. Cum. Third Pref.	5	6⅛-6⅜
—— 3½ per cent. Deb. Stock	100	106-108
Notting Hill Company	10	8¼-9¼
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7⅛-7⅞
—— £4½ shares	4½	6-6½
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-107
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8⅛-8⅜
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4⅛-4⅜
Westminster Electric Supply, Ordinary	5	8⅞-9⅛
Yorkshire House-to-House	5	—

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NOTES.

The Telephone in Western Australia.—A telephone exchange is shortly to be established in Coolgardie.

Telephones in Mexico.—A telephone line is to be established between Ario and La Huacana, in the State of Michoacán.

The Telephone in Germany.—On September 25 telephonic communication between Berlin and Königsberg, in Prussia, was established. The charge for a conversation of three minutes is one mark.

Telegraphs in Siberia.—A telegram from St. Petersburg states that a telegraph line is to be established between Bachta and Tchugutscheek in Siberia, which will primarily facilitate telegraphic communication with Western China.

Electricity on the Brooklyn Bridge.—At a recent meeting of the trustees of the Brooklyn Bridge a resolution was passed instructing the chief engineer to "investigate the subject of electric motive power for the propulsion and switching of trains on the bridge."

Society of Engineers.—The next ordinary meeting of this society will be held at the Royal United Service Institution, Whitehall, on Monday, October 7, when a paper will be read on "The Relative Value of Percolation Gauges," by Mr. Reginald E. Middleton.

The Berlin Exhibition, 1896.—The Working Committee of the Berlin Industrial Exhibition of 1896 request intending exhibitors to immediately inform them of the exact amount of light and power, either electrical or gas, which they will require. Replies must state the number of 16-c.p. incandescent lamps, and of 500-800-c.p. arc lamps needed.

City and Guilds of London Institute.—At the recent matriculation examination of the City and Guilds Central Technical College, 76 candidates presented themselves, and 62 have been admitted to the college. The highest place was taken by M. Solomon, to whom the Clothworkers' scholarship of £60 a year and free education has been awarded.

Proposed New Atlantic Cable.—According to the *Figaro*, M. Lebon, the French Minister of Posts and Telegraphs, has announced to the members of the Calais Chamber of Commerce that he has signed a contract for the laying of a submarine cable from Brest to New York, which will be connected with the French telegraph system in the Antilles. The contract, which bears a large number of signatures, will, it is said, be presented to the Chambers when they reassemble.

Electric Railways in Peru.—It is announced that a representative from the Baldwin Locomotive Works, and an expert electrical engineer from the Westinghouse Company, together with Sir Henry Tyler, ex-president of the Grand Trunk Railway, have left for Peru, where a test of the possible powers of the electric locomotive is to be made upon a railway 15,000ft. above the sea-level. Sir Henry Tyler, it appears, was recently in Philadelphia in conference with members of the Baldwin firm on the subject.

Accumulator Traction in Germany and Holland. The *Kölnische Zeitung* announces that experiments in Hanover with accumulators (rapid-charging system), for traction purposes have given such satisfaction, that the tramway company of that city has resolved to adapt 28 cars, at present used with overhead conductors, for the reception of storage batteries. The paper states, moreover, that the Dresden Tramway Company and the Hague Tramway Maatschappy have also decided to try accumulator traction.

The Pacific Cable.—Colonel Spaulding, who lately acquired from the Hawaiian Government a license to lay a cable between the Sandwich Islands and San Francisco, is at present in Washington, and at an early date will, it is said, submit a proposition for the cable, and will ask for aid from the American Government. Colonel Spaulding expects to get private subscriptions to the amount of 1,000,000dol., and he anticipates that the United States Government will furnish the balance.

The Cattori Electric Railway System.—A Roman commercial paper—the *Bollettino delle Finanze*—has printed a long account of a system of electric traction devised by a Captain Cattori, in which neither underground nor overhead conductors are used, "the current, without inconvenience of any sort, and with perfect safety for the person, being conveyed upon the rails serving for the traction. The distribution of the current is made in series, the two rails forming a sole conductor, the return being through an overhead wire" (!)

The Durability of Asphalte Cables.—Herr Görz, of St. Petersburg, writing in the *Elektrotechnische Zeitschrift* on the proposed German wiring rules, and suggesting several amendments, refers to the question of the durability of insulated cables. He states that the whole underground network of the St. Petersburg electric supply station consists of lead-covered asphalte Siemens-Halske cables, which have been working for the last six or seven years to entire satisfaction. The expenditure for repairs and renewals for the past year was only ½ per cent. of the total expenditure of 1,100,000 silver roubles on cables.

"The Coolest Place in London."—The management of the City and South London Railway is nothing if it is not ingenious. During the recent spell of sweltering weather, in order to attract passengers it hung huge placards outside the various stations announcing the fact that "the electric railway is the coolest place in London." The officials say that the announcement has had a great effect, and that during the past week men of Falstaffian proportions, who perspire painfully, or as the Shakesperian phrase hath it, "lard the lean earth," have spent the best part of their afternoon in travelling to and fro in the coolest place in London. The summer heat has, of course, hitherto been considered to be the bugbear of the subterranean undertaking.

The Spanish Telegraph Service is being hotly attacked again. In a recent article, entitled "Disaster Approaches," *El Telegrafista Español* says: "All the Madrid and a considerable portion of the provincial Press, without distinction of party, have entered upon a campaign, none the less energetic for being brief, against the telegraph service, which is not a service because its constitution renders that impossible; nor is it a *renta* (revenue), because that could not be the case in this country, where the word *renta* is understood in the sense of impost, duty; and," adds the journal, "the Press is quite right." It is well to note, turning to a more peaceful subject, that the Madrid Tramway Company has requested license from the authorities concerned to substitute electric for animal traction on its principal lines.

Electric Keno.—A new game of chance has been devised, in which the ordinary electric fan plays an important part. The only requisites are the "current" and a goodly supply of small coins. The rules governing the game are simple. Each of the blades is numbered, the numbers running from one upwards. A corresponding set

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of numbers and small circles is marked on a sheet of paper, and the game proceeds. Each player covers a number with a coin, the current is turned on, and the fan buzzes gaily for a minute. Then it is suddenly shut off, and as the revolutions grow slower, every player watches to see which blade will be uppermost, the centre of the screen having been marked. The man who covers that number wins all the money, the numbers are again covered, and away goes the fan on another whirl.

"Queer Crankism" of Electricity.—A Boston journal says that "North Adams continues to be puzzled over a queer crankism of electricity in its vicinity. Although when the great 4½-mile Hoosac tunnel was built no ores, magnetic or otherwise, were encountered, there was general expectation that rich ore pockets would be found, yet for an unexplained reason not an electrician has been discovered who can send a telegraphic message on a wire running from portal to portal of that tunnel, be such wire run inside of an ocean cable through the huge cavern or out of it. Therefore, such messages have to be sent on wires strung on poles over the top of the mountain, fully nine miles, and that is the way ingoing and outgoing passenger and freight trains are heralded to the keepers of the two tunnel approaches."

The Utilisation of Finnish Waterfalls.—The Russian Ministry for the Interior has been applied to for the granting of a concession for the formation of a limited company to utilise the famous waterfalls of Imatra and Narva. The plan comprises the transmission of the electric power to places at a considerable distance, both for factories and for electric lighting purposes. The scheme embraces not only Finnish towns, like Viborg, Helsingfors, and others, but also St. Petersburg, Riga, Reval, and still more distant places. The Russian authorities are understood to view the plan with favour, although in engineering circles it is hardly considered feasible. As the capital required would be larger than what the promoters consider it possible to raise in Russia, it is contemplated to try and interest foreign capitalists in the undertaking. The Finnish Senate have been requested to give their opinion in reference to the scheme.

Electricity in Mines.—At a recent meeting of the German Miners' Council at Hanover, a communication was made by Herr Doeltz, mining assessor, of Hanover, on the employment of electric transport in mining work. The power developed by electric currents, the difference between continuous and alternating currents, the employment of electric motors for accelerating work, and the strength of conductors were illustrated by drawings. Superintendent-engineer J. Körting-Körtingsdorf spoke on the application of gas motors to transport work. Steam power would cease to give satisfaction now that electric power and gas-engines had been taken up. Small steam-engines had already been everywhere replaced by the latter; gas-engines had also recommended themselves to the needs of large decentralised businesses; the best results would be obtained by the combination of gas power with electricity.

The Electric Light in Belgium.—With a desire to further encourage the use of electricity by private persons, the Communal Council of Brussels has decided to reduce the tariff. A kilowatt-hour is, in future, to cost 70 centimes instead of 80 centimes; further, when every lamp used by a subscriber is kept running for an average of 1,000 hours per year the price will be reduced 5 per cent., and the reduction will continue in proportion to the consumption until a price of 60 centimes per kilowatt-hour is reached. The tariff for illuminated advertisements and signs, and or outdoor lighting, is to be 50 centimes per kilowatt-hour. In the course of the second year of working the city hopes to have completed two secondary stations in the upper part of the city, as well as the laying of mains in the Quartier Léopold and the Quartier Louise. The expenditure involved will ultimately amount to about 3½ million francs, and an increase in the private consumption is counted upon to insure a financial success.

Electric Carriage.—It is announced that a carriage propelled by electricity, such as those which some time ago made the journey between Bordeaux and Paris, will shortly make a long run of over 1,000 miles in Italy. It is the property of Cavalier Giuseppe Ricorde, who will conduct it himself. Starting from Milan it will go *vid* Brescia, Piacenza, Parma, Reggio, Modena,. Bologna, Florence, Rome, Naples, Civita Vecchia, Leghorn, Spezia, Genoa, Savona, Turin, and Milan. The carriage contains four seats, and can proceed at the rate of from seven to ten miles an hour. Signor Ricorde is a well-known sportsman, and is said to be always ready to encourage any new invention. By the way, the Paris publication *Le Vélo* states that some of the French competitors in the late horseless contests will visit Tunbridge Wells on the day of Sir David Salomon's experiments in the stock show meadows. Considerable interest is being taken in horseless carriages in America at the present time through the Chicago *Times-Herald* prize contest for horseless carriages to run from Milwaukee, Wis., to Chicago, on November 2 next.

Obituary.—Kommerzienrath Joh. Sigmund Schuckert, who died on 17th ult. at Wiesbaden, at the age of 49, after a long illness, was a remarkable figure in German electrical science and electrical industry. Born at Nuremberg (in 1846), after receiving instruction in his native town, young Schuckert spent five years in various works in Stuttgart, Hanover, Hamburg, and Berlin, whence he proceeded to America, where he was employed at New York, Baltimore, Cincinnati, and Newark. In 1873, upon his return to Germany, he started a small works in Nuremberg, and constructed his first flat-ring machines, a type which, in France, has been exploited by M. Fabius Henrion, who was long his representative in that country. A large number of electric central stations were erected by the firm which Herr Schuckert founded, and which, since 1893, has been known as the Elektricitäts-Actiengesellschaft vorm. Schuckert und Co. A tolerably prolific inventor, his name will especially be associated with the Pilsen arc lamp and the celebrated parabolic projectors, regarding whose merits and those of the production of a rival French firm a discussion between the principal parties interested was recently waged in these columns. The premature death of such a man is eminently to be regretted.

Coming to England.—We read the following in a Transatlantic contemporary: "H. B. Cox, of Hartford, Conn., the inventor of a means of converting heat into electricity, is leaving to take up his permanent residence in England, where capital has been furnished him to engage in the manufacture of the apparatus designed to carry out his plans. The British Government has already given Mr. Cox orders for 10,000 of his machines for the telegraph service. Sub-companies will also be formed in France, Germany, Belgium, etc. A strange feature of Mr. Cox's experience in this country is the fact that though he had 100,000dol. worth of *bonâ fide* orders from such companies as the Postal Telegraph Company, the Metropolitan and New York and New Jersey Telephone Companies, yet he could not raise 25,000dol. on them by which to carry on their manufacture. The electric light, as it burns in everyday use, converts electricity into heat. Mr. Cox says his invention is simply a reversal of this process. He says he converts heat directly into electricity, turning heat vibrations into elec-

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tricity vibrations. The idea has been known since 1821. What he claims as his own is the making this practicable. He says the Commercial Cable Company, after putting it in daily use, declared that his machine did its work at one-eighth the present cost. The uses that the Cox machines are designed for are to light private houses, for ship lights, for lighthouses, for telegraph and telephone, for electric bells, for boat propulsion, and the general purposes of small motors. Lord Kelvin is cited by Mr. Cox as pronouncing this invention most remarkable, and just what is needed."

Mnemonic Rules in Electricity.—M. R. Busquet, writing on this subject in *L'Eclairage Electrique* of September 21, considers the simplest and most easily remembered rule to be Maxwell's analogy of a corkscrew—*i.e.*, if the corkscrew is advancing in the same direction as the current, the direction of the lines of force produced is the same as the direction of the corkscrew's rotation and reciprocally. Since the magnetic needle sets itself along the lines of force, this includes Oersted's rule. In the case of induction M. Busquet also rejects Faraday and Fleming's rules in favour of Maxwell's: that in a closed circuit, when the lines of force decrease, the direction of the current is the same as the rotation of a corkscrew, screwing into the circuit along the lines of force, and contrary when the lines of force are increasing. M. Busquet, however, thinks the rule might be made more complete by imagining the cork as well as the corkscrew to be movable, or by the analogy of the small hand-drills rotated by a screw and collar which are used for drilling thin pieces of wood or iron. Representing the increase and decrease of the lines of force as produced by the approach or withdrawal of the north pole of a magnet along the axis of the circuit, then if the advance of the screw shaft corresponds to the introduction of additional lines of force, the current will be counter-clock-wise, and will correspond to the direction in which the collar will rotate if the screw shaft is not allowed to turn. Reciprocally withdrawing the screw corresponds to taking out the lines of force, and gives a rotation to the collar in the same direction as the hands of a clock, which would be the direction of the current. M. Busquet further shows that the analogy of the screw and collar can be applied to a conductor moving in a magnetic field, and also to determine the field produced by a current in a rectilinear conductor, the collar being always considered movable when induction is dealt with.

Train Electric Lighting in Ireland.—An important development in train electric lighting was tested the other day on the Great Northern of Ireland Railway, the run being between Amiens-street, Dublin, and Drogheda and back again. A good many electrical engineers accompanied the party, and among the company were the general manager of the Great Northern Company, Mr. Thomas Robertson, Mr. Thomas Wallace, superintendent of the line, and several of the officials. The train was one which had just been turned out of the company's workshops at Dundalk. The main features of the lighting system are that each vehicle is provided with its own generating plant, and is in all respects complete in itself, the revolution of the axle of the carriage driving the dynamo producing the electricity for lighting the train while in motion, and storing sufficient current in the accumulators to light the lamps when the train may be standing at stations. The entire plant consists of a dynamo, which feeds accumulators placed underneath each carriage. The dynamo commences work as soon as the carriage moves, and the accumulators automatically come into action immediately the train slackens speed or stops at stations. The system, of course, obviates the necessity for providing generating plant at terminal stations for charging purposes. The train was electrically equipped by Messrs. J. Stone and Co., engineers and electricians, of London, the system being the invention of Mr. Arthur Gill, manager of their electrical department. The Great Northern Railway Company have three systems of train electric lighting at present in operation on their lines. The first is lighting from accumulators underneath each carriage, these accumulators requiring to be charged daily at terminal stations. In the second system the electricity is produced by a dynamo driven off the axle of the guard's van. The generating plant is also placed in the guard's van, and the entire train is lighted therefrom. The third system is the one which has just been tried. During the run up from Drogheda, which was accomplished in less than three-quarters of an hour, the lamps are said to have burned brightly. It is intended to place four five-candle lamps in the first-class compartments, two eight-candle lamps in the second-class, and two five-candle lamps in the third-class compartments. The experimental run made was conceded to be highly satisfactory.

An Electric Brake.—A braking apparatus, the patent rights of which have been acquired by the General Electric Company, is operated by the current from the motors when they have been reversed and act as generators, as a result of the momentum of the car. The controller consists of three cylinders, a controlling cylinder for the motors when working as motors, a brake cylinder or controller for the motors when reversed and operating as generators, and a receiving cylinder or switch. These three cylinders are provided with separate handles and an interlocking mechanism which is designed to prevent improper manipulation. The interlocking mechanism is also so arranged that a different throw is permitted to the brake cylinder when the car is going in one direction from that allowed when it is moving in the opposite direction. Under ordinary circumstances it is unnecessary to arrange the brake so that it will work when the car is moving backwards, as the backing of cars is contrary to the rules of some tramways; but in cases where a car is run backwards for a few feet, as on a switch or turnout, it is sometimes necessary to stop abruptly. For making such emergency stops the brake is arranged so that where there are successively graduated effects in applying it when running forward, this part of the cylinder remains idle when the car is moving backwards and an auxiliary set of contacts come into play, which apply the full force of the brake at once. With either the series-parallel controller or the ordinary resistance switch, the contacts upon the braking switch cylinder co-operate with the controlling cylinder. These connecting contacts render possible an important economy in the car wiring, as a considerable length of wire can be saved in equipping the circuits of the apparatus. The controller is provided with two bolts, serving as an interlock between the reversing switch and the controller and between the brake switch and controller. Lugs secured to the controller case have openings which form guides for the interlocking bolts, and the shaft of the controlling switch is provided with two notched collars, with which the ends of the bolts register. The notches indicate the off position of the controlling switch, and it is only in this position that it is possible to operate with the brake or reversing switch.

Electrical Progress in Japan.—The use of water power for the generation of electric current for street railway and other purposes is receiving considerable attention in Japan at the present time, and several undertakings are now, a correspondent says, being developed with this object in view. There is already one such plant in operation, and it is working very successfully—the street railway in Kyoto.

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The line is 12 miles in length, and is operated on the single-trolley system. It has given such excellent results that in other cities—including Tokio, Yokohama, and Osaka—permission is being sought for building lines on the same system. The authorities of Osaka and Tokio, however, hesitate about granting the permission desired on account of the possible damage to water-pipes, which are being now laid down. What makes it so much harder to push the single-trolley enterprise in Tokio are the efforts of another syndicate to introduce the double-trolley system. This syndicate represents a capital of 1,900,000dol., and proposes to build 84 miles of road. Upon the settlement of the question in Tokio the result of the agitation in other Japanese cities will much depend, and in all places everything is ready for active operations as soon as the matter is settled and the desired permission obtained. Eight mines in Japan are worked by electric power and lighted by electricity, all the generators, motors, and incandescent lamps being, the correspondent adds, manufactured in Japan—but this we doubt. Excepting a special form of telephone, and the agglomerate carbon for the Leclanché battery, all the instruments and battery materials used in the Japanese telegraph and telephone services are also, it is stated, manufactured and supplied by native concerns. The following statistics concerning electric lighting in the three largest cities of Japan are interesting:

	Population.	No. incandescent lamps, 8 c.p.	Arc lamps, 1,200 c.p.
Tokio	1,303,876	 34,436	 160
Osaka.....	484,409	 22,203	 140
Kyoto	328,403	 12,638	 19

A preliminary survey has, moreover, been made by the Japanese authorities for the laying of a submarine cable to Formosa. Another correspondent writes that the municipal authorities of Tokio, in accordance with the recommendations of a committee of scientists and chiefs of municipal departments, have decided to avoid the electrolytic corrosion of the existing water-pipes and interference on the single-line telephone circuits by compelling the use of the double trolley over the projected 85 miles of roads in that city.

The Increased Voltage Question.—Mr. Sydney W. Baynes says that pressure of work makes it difficult for him to maintain a correspondence on the question of the increased pressure supplied at St. Pancras. He writes: "In reply to Dr. Fleming, I gather the gist of his remarks to be that very careful inspection and testing will be found necessary. This is an essential point in any well-regulated central station, and applies equally to a five-wire, high-tension alternating, or high-tension continuous-current system. I wish to make it clear that no sweeping change of voltage is contemplated. The consumers already supplied at 110 volts will continue to receive that voltage, and it is optional for them to change if they consider the lighting obtained from the higher voltage to be more satisfactory. I have had consumers owning two sets of premises, having 230-volt lamps in one and 115-volt in the other. After a fair trial of the two, they decided to replace the low-voltage lamps with the higher voltage. It seems strange that Messrs. Handcock and Dykes having "past experience with 220-volt installations" should have any difficulty in knowing where to procure lamps of that voltage. I regret I have not the pleasure of knowing these gentlemen, as it may be that, having an interest in the lamp-making industry, they feel somewhat aggrieved at not being ready to meet the demand; but the loss has no need to be of a permanent nature, as the field is open to all. As to their invitation to repeat my experiments through the medium of an expert, much as I should like to assist my friends in their thirst for knowledge, I am not at their service in this respect. I have had close on two years' labour in this direction. Let them study the matter for a similar period and then they will better understand the subject. What, for instance, do they mean by asking me to submit a 220-volt lamp to a total variation of 8 per cent., which is equivalent to a continual fluctuation of nearly 18 volts? No, I must decline with thanks, and suggest that when central-station engineers are allowed a latitude of 18 volts in the regulation they will conclude that the millennium is not far distant." Mr. Baynes remarks that this letter closes the correspondence as far as he is concerned. Messrs. Handcock and Dykes have since stated that they are not interested to the extent of a single penny in any electrical manufacture whatever.

The Physiology of Death by Electric Shock.—Mr. Henry McClure remarks on this much-discussed subject: "That strong arterial contraction and engorgement of the large veins and right side of the heart are present in death from electric shock cannot, I believe, be contested. The contraction of the arteries is unquestionably due to a physical cause, but I do not think with Dr. Shettle that this cause acts primarily on the contents of the vessels (blood being a conductor), but rather upon the badly conducting or insulating nerves and arterial centres. Faraday taught us long ago that the seat of the phenomena was not in the conductors, but in the insulating medium surrounding them. The electrical energy does not travel by the wire but by the insulating sheath or dielectric surrounding it; the function of the wire is to dissipate the energy crowding into it from the dielectric, which else would take up a state of strain and cease to transmit any more. The blood, fluids, and opaque tissues of the human body act as the conductors, or wires, and the transparent tissues as the dielectrics, and these transmit all the energy. This I have tried to explain elsewhere. The kinetic electricity in traversing such tissues becomes static, resulting in a strain of the medium; the shearing stress of the current has altered the condition of the molecules; there is no displacement of the molecules as a whole, as has been pointed out by Prof. Lodge, but of their constituent atoms, and the stress, if strong enough, may result in electrolytic disruption. There is tension along the lines on which electricity is travelling and pressure at right angles to this. This is just the force that would narrow the calibre of the artery; this atomic displacement is most probably propagated along the nerve in the same manner as in the causation of muscular contraction. It is a spring back force, and under normal conditions would stimulate at make and break of the current, but under the conditions we are considering the molecular structure has been so altered by death that there is no spring back possible, the arteries remaining permanently contracted." It is interesting in this connection to note the recent experience of the crew of a fishing-vessel, belonging to Queenstown, which was struck by lightning in Courtmacsherry Bay. According to the captain's report, the entire crew were disabled by the electric discharge, being insensible for several minutes and then for a considerable time blind and deaf. When the storm came on, and the lightning played, the iron tiller was taken out of the rudder and replaced by a wooden one. Almost at the same moment the vessel was struck by "what appeared to be several pieces of fiery metal," and the noise made is described as "awful." When the crew recovered their sight and hearing, they found that the mainsail had been burned, the gaff broken, the deck planks burst open, galvanised hooks and thimbles had melted like lead, and the forecastle funnel had been twisted out of shape.

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TUNBRIDGE WELLS ELECTRICITY WORKS.

This fashionable watering-place and health resort, which is situated on the border line between Kent and Sussex, is noted for its beautiful surroundings, and for the medicinal properties of the mineral waters found in the neighbourhood. The town, which was incorporated in recent years,

SIR DAVID SALOMONS, J.P., MAYOR.

has increased rapidly in size and importance. It is very opportune that the electric lighting enterprise at Tunbridge Wells should be completed during the mayoralty of Sir David Salomons. The history of the movement shows somewhat slow progress in the first instance. In 1890 a provisional order was applied for by the Corporation to keep an outside competitor from gaining the monopoly. The order being obtained, the matter was allowed to rest till the three years allowed by the Board of Trade had nearly expired. In the interval, however, an attempt was made to get rid of the responsibility and to sell the right to some private firm or company. This fortunately proved futile, and finally, in August, 1892, the Corporation called in Mr. W. H. Preece to give them a report as to the best means of lighting the borough. He most strongly advised them to keep the enterprise in their own hands, and by examples from other towns showed that the cost to the ratepayers at first would be more than balanced by the advantages derived and the profit earned in years to come. Considering the scattered area which would need the light, Mr. Preece stated that the alternating current must be employed wherever the station was to be placed. Considering the various sites available, together with the high-pressure system, he selected the present site, in the Corporation yard, by the goods station. The total preliminary cost he recommended was £25,000. Unfortunately, the matter came up before the Council for decision at a time when a new water-supply question had arisen which appeared likely to cause a large expenditure. The electric lighting question was therefore postponed again, and when finally undertaken, only £13,000 out of the £25,000 was asked for. As a consequence the money borrowed was insufficient to provided for reasonable contingencies and any little extensions required to supply demands for light. Hence the outlay of the remaining £12,000 has already been sanctioned. Mr. Preece at first recommended that the charge per unit should be 8d., but this charge was reduced to 6d. per B.T.U. before the supply began. The demand for light has, in consequence, been much increased, and already the equivalents of some 4,000 lamps have been connected to the mains. During this year Sir David Salomons, as mayor, has given the electricity department his energetic support, and has done all in his power to popularise the new illuminant. As an example of his untiring effort, we give below the programme of the official inauguration, which is to take place on Wednesday next. The borough electrical engineer, Mr. H. L. P. Boot, was appointed early in July, and under his direction the work of connecting consumers, etc., has progressed rapidly. The following gentlemen at present form the Electric Lighting Committee: chairman, Councillor T. Ashby Wood; his Worship the Mayor (Sir David Salomons), Aldermen Pink, Robb, and Clifford, Councillors Howis, Tinné, and Finch.

THE PANTILES, TUNBRIDGE WELLS.

The following is the programme of proceedings at the opening of the municipal electricity works at Tunbridge Wells on Wednesday, October 9, 1895:

1 p.m.—The Mayor has kindly consented to provide refreshments in the Camden Hall at 1 p.m., where the

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Council, officials, and guests will assemble. Mr. Councillor Ashby Wood (as chairman of the Lighting Committee) will then make a speech, to which the Mayor will reply, and will then call upon Mr. W. H. Preece for a few remarks. The health of, and a vote of thanks to, the Mayoress will be proposed and seconded, which Sir David will acknowledge.

2 p.m.—Carriages will be in waiting to convey the company to the electricity works; where the machinery will be running, and the Mayor, after a few remarks, will ask the Mayoress to switch on the electric light.

3 p.m.—On leaving the works a procession will be formed in the following order: four mounted constables, Sir David's petroleum carriage (to be drawn on a trolley supplied by Mr. Smith), police force, military band, workmen employed in laying the mains, steam fire brigade, manual engine, members of the cyclist club, Cygnus Club, harriers and gymnastic club, salvage corps, Press (in carriages), Rusthall Fire Brigade, tradesmen's association, officials of the Corporation, councillors, aldermen, fire brigade, Ceylon Band, Lighting Committee, the Mayor and Mayoress (escorted by the yeomanry), St. John's Ambulance, visitors, etc.

The procession will pass through the principal streets to the Town Hall, where the Mayor and Mayoress, accompanied by the Corporation, will visit the electrical exhibition. This exhibition will be open to the public on Monday, October 7, at 4 p.m., and close on Saturday, October 12, at 11 p.m. The exhibits will include all kinds of electrical lamps, fittings, and appliances, electric motors, engines, dynamos, cooking, heating, and domestic applications of electricity. The kinetescope and phonograph also will be on view. During the afternoon and evening of each day, selections of music will be given.

General Description of Works.

The site finally selected for the works is most conveniently arranged for coal and water supply. As will be seen from Fig. 1, the buildings adjoin the goods station of the South-Eastern Railway, so that all the coal required can be shot from the trucks on the siding directly into the bunkers. In the immediate vicinity are the old reservoirs

H. L. P. BOOT, A.M.I.C.E.I. A.I.E.E., M S.A., BOROUGH ELECTRICAL ENGINEER.

which used to supply drinking-water to the town. The quantity of water in them would be ample for condensing purposes, but the largest one is at present used as a swimming-bath, and hence is not available. Still, by sinking a well at the rear of the station a good supply of water

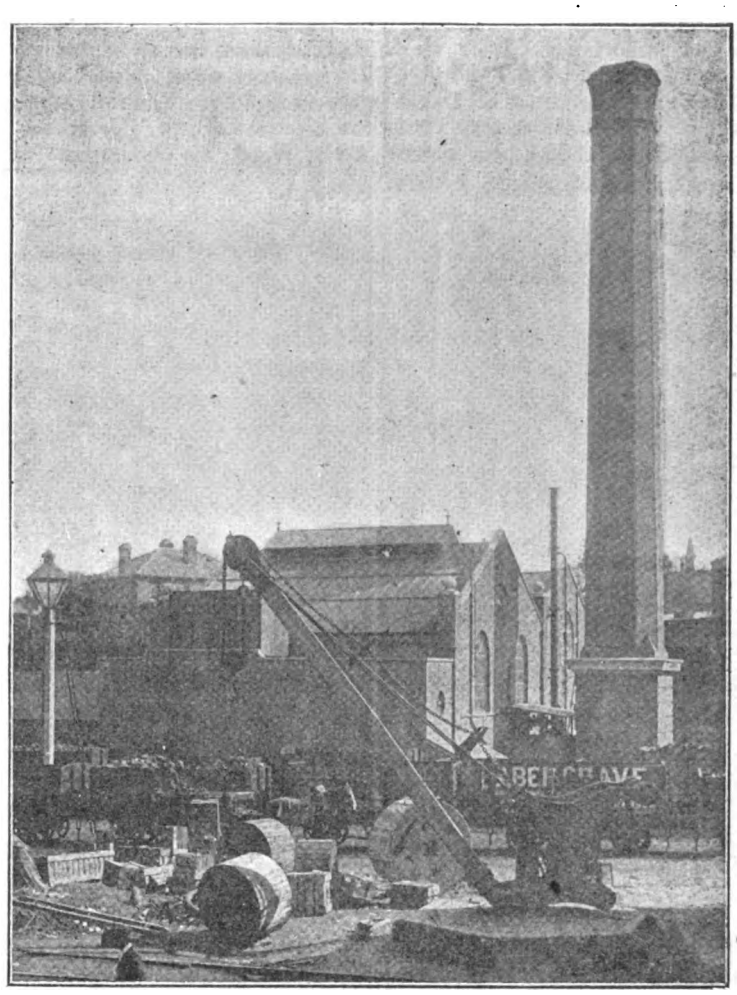

FIG. 1.—View of Station from Railway Embankment.

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suitable for boiler-feed purposes has been obtained. The town supply is, however, laid on in case of emergency.

F.R.I.B.A., of Westminster. The general architecture will be seen from Fig. 2, which gives a perspective view of

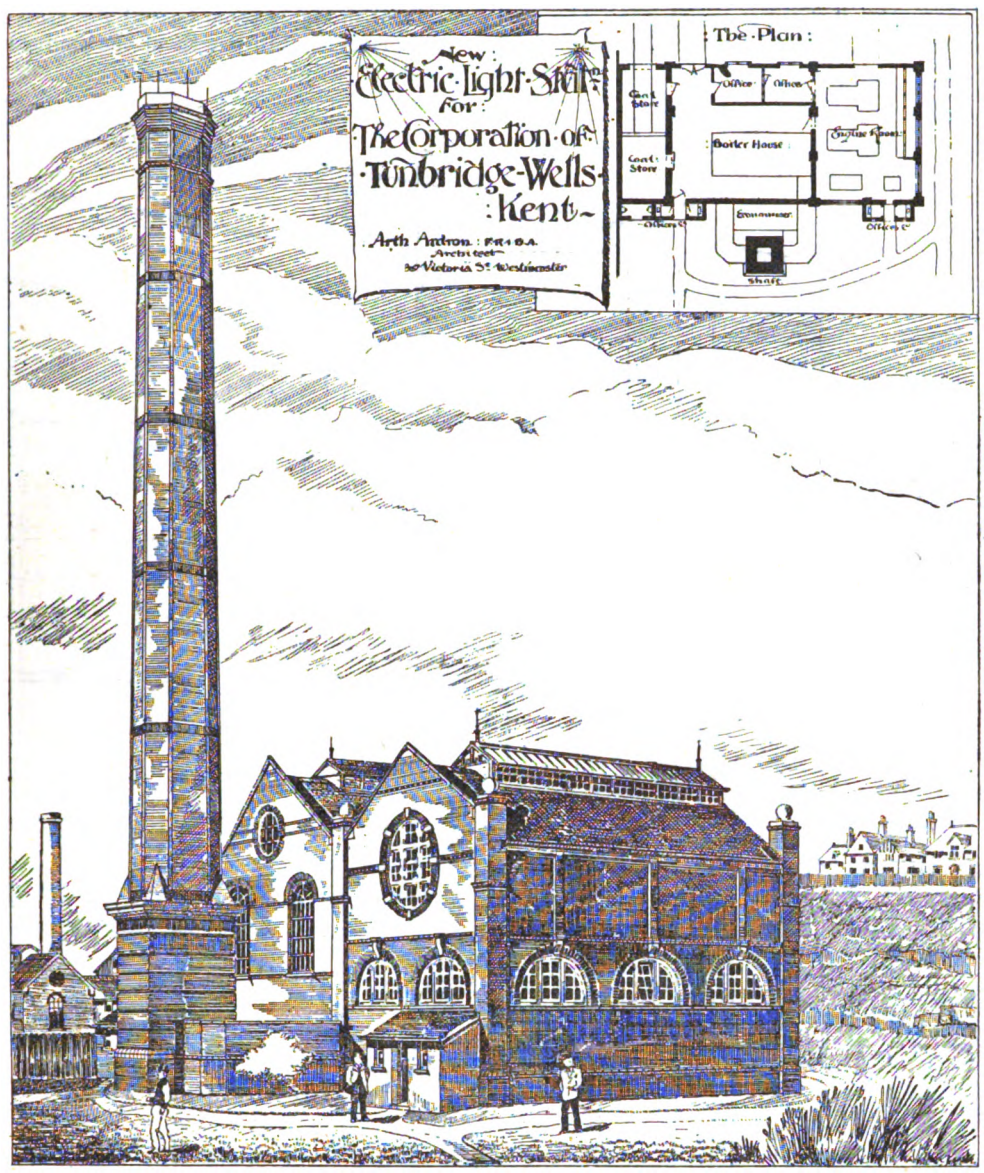

FIG. 2.—Elevation of the Tunbridge Wells Electricity Works.

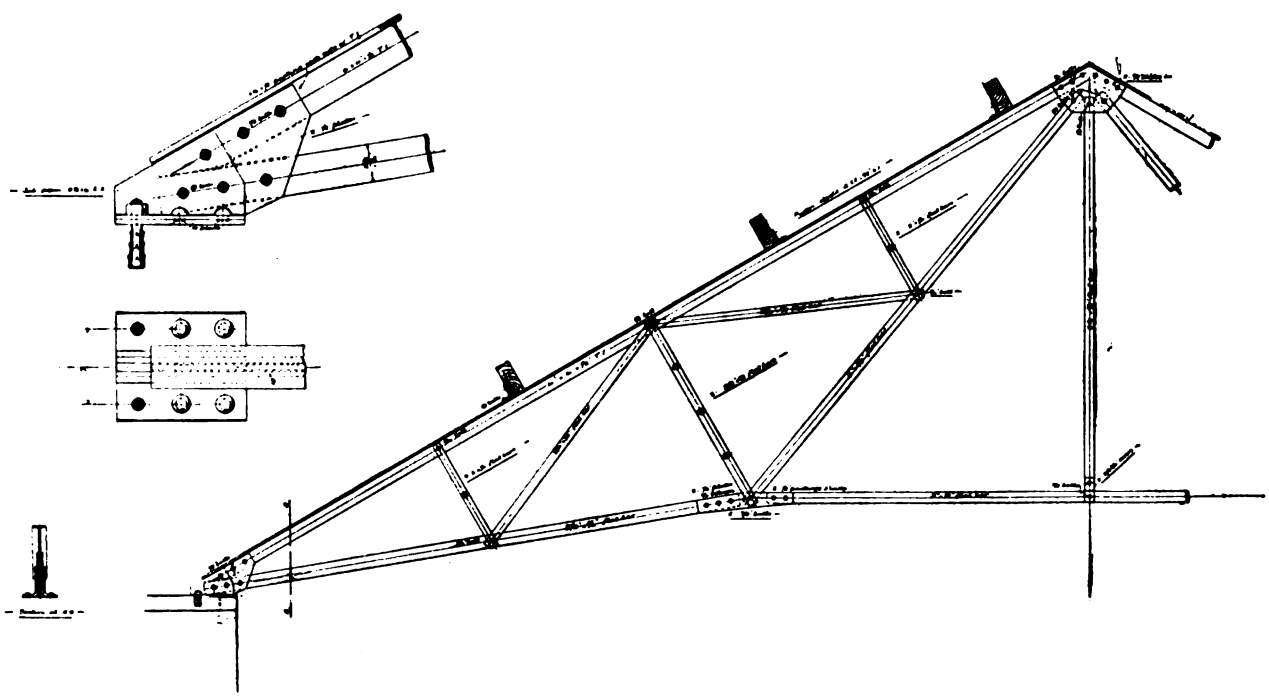

FIG. 3.—Details of Boiler-house Roof.

The buildings, which are arranged so that they can be conveniently extended, were designed by Mr. A. Ardon, the chimney and buildings. The interior is lined with white glazed bricks, with a coloured line about 4ft. from

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the floor, which gives a pleasing effect. The details of the roof over the boiler-room are given in Fig. 3. The ground plan of the building, showing the machinery in position, is given in Fig. 4. From this it will be seen that the present plant consists of two 75-kilowatt alternators made by light mains. There are two of these rectifying sets—one for use and the other as a stand-by. The switchboard, supplied by Crompton and Co., is conveniently arranged at the side, with ample room behind for access. An overhead traveller runs the full length of the engine-room.

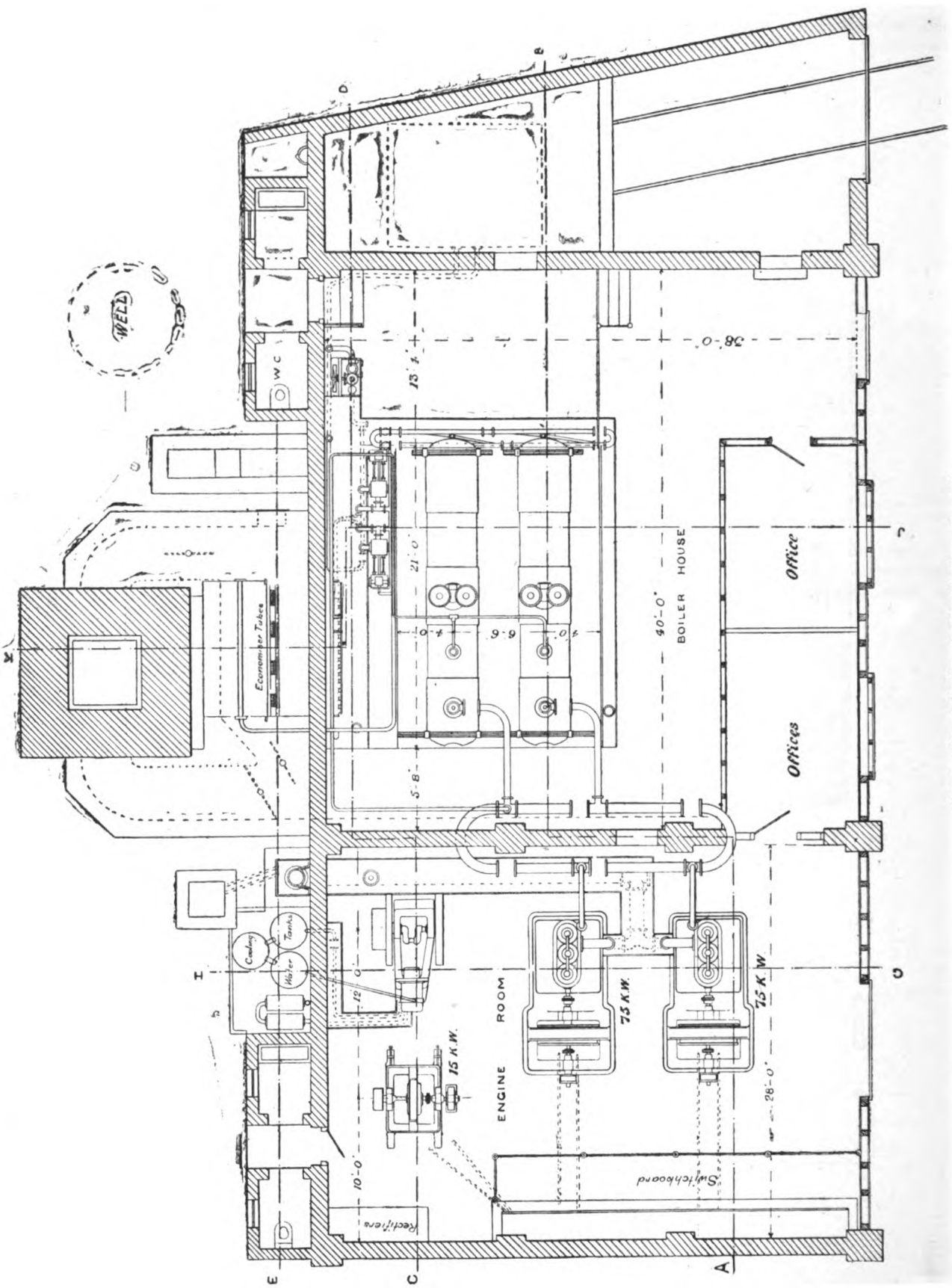

Fig. 4.—Plan of Station, showing Machinery in position.

Messrs. Johnson and Phillips, coupled direct to two Willans engines, which take the evening loads. Besides these, a Stockport gas-engine of 15 nominal horse-power is provided and connected by link belting to a 15-kilowatt alternator as a daylight plant and to take the light loads. In the corner, beside this alternator, the two Ferranti rectifiers are placed, which are required to supply the arc

Steam Generating Plant.

The boiler contract was placed with Messrs. Babcock, Wilcox, and Co., who have installed two of their tubular boilers. Each of these has a heating surface of 1,426 square feet, and is composed of eight sections of tubes. Each section is nine tubes high, the tubes being 16ft. long and 4in. diameter. The steam and water drum is 42in. diameter.

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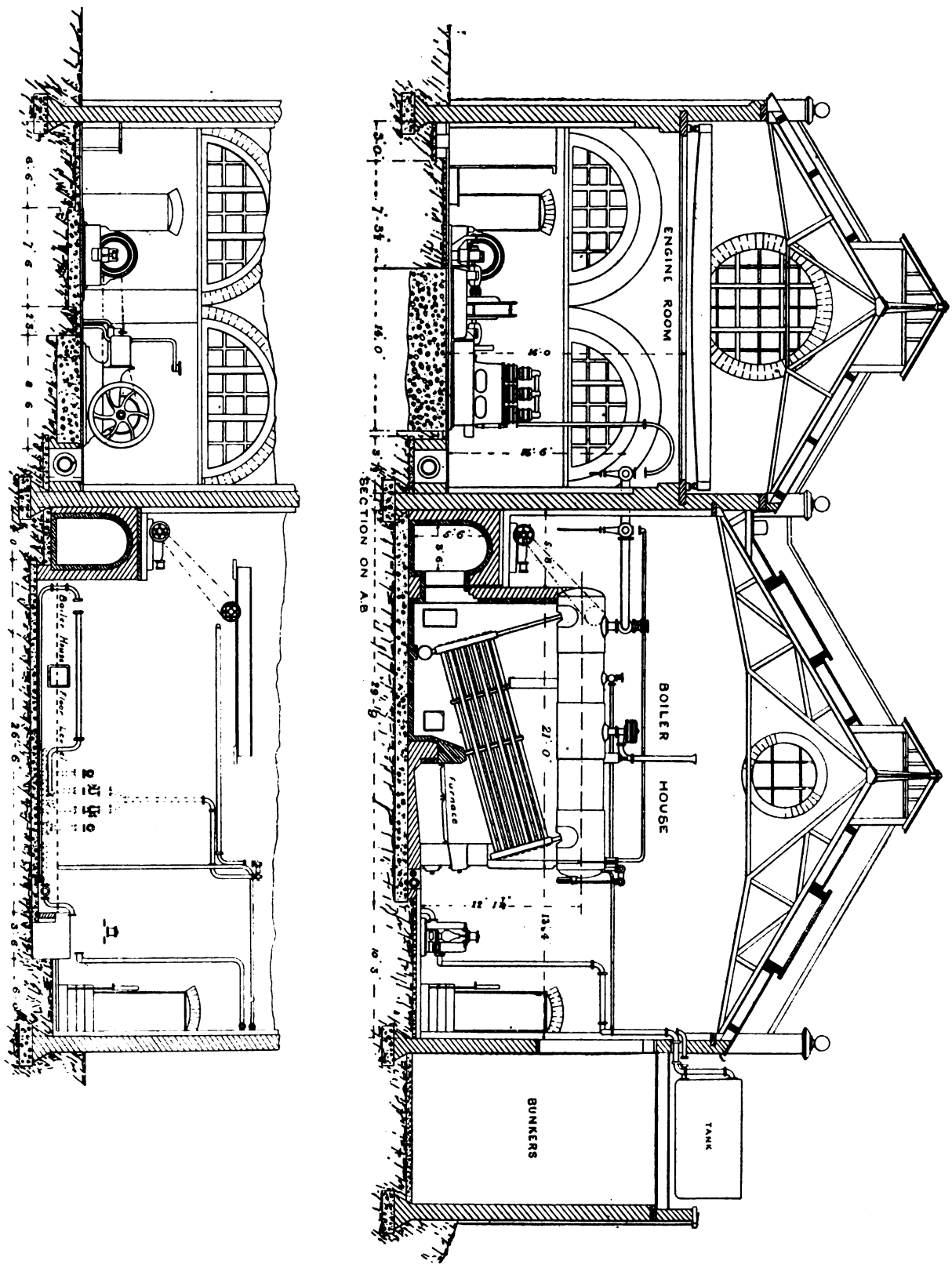
The working pressure is 150lb. per square inch, and the boilers were tested to 250lb. per square inch after erection. Two dead-weight confined-flow safety-valves are fitted on each boiler, and are connected to an escape-pipe which goes outside the building. The boilers were constructed under the inspection of the National Boiler Insurance Company, of Manchester, and are fitted with isolating valves next to the main stop-valves, also with Probert and Bridges's low-water alarms.



FIGS. 5 AND 6.—Sectional Elevations of Station.

Messrs. Babcock, Wilcox, and Co. also supplied the Westinghouse feed-pumps and all the necessary parts of the duplicate feed-pipe service, which can be seen from Figs. 4, 5, and 6. The large tank placed over the coal-stores is made of boiler plate, and has a capacity of 5,000 gallons. This is used to store the feed water, which is pumped up from the well by the donkey pump placed in the corner of the boiler-house. The same firm supplied the Green's economiser, which contains 128 tubes, and is provided with a small engine, shafting, etc., for working the scraping gear. The arrangement of flues will be seen from Figs. 4 and 6A, and as the boilers for future extension will be placed where the temporary offices now are, the main flue can be conveniently lengthened.

Steam and Exhaust Pipes.

The work in connection with both the exhaust and steam pipes was carried out by Messrs. Willans and Robinson. The main steam-pipe is 6in. diameter, and is arranged on the ring system, so that any one defective joint or section will not interrupt the steam supply. The pipes are of wrought iron, with Willans patent flange connections. The bends, however, are made of copper. The whole system is supported on brackets, so that the expansion of the pipe shall not cause undue strains in it. The steam-pipe is thus

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overhead, and the valves are not so accessible as might be desired. Hopkinson valves are used throughout the steam-

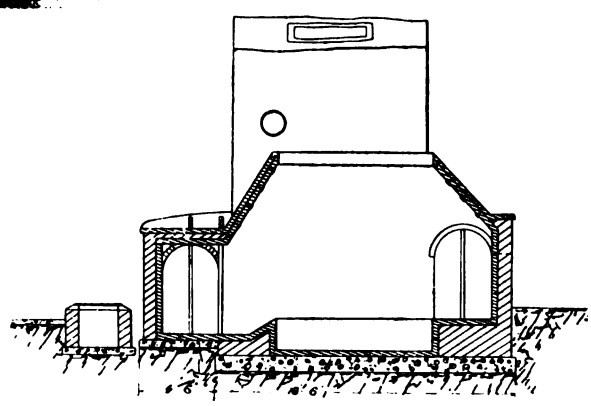


FIG. 6A.—Details of Flues and Chimney.

ring and on the connections. The exhaust-pipes are laid underground in trenches left round the foundations of the engines. The main exhaust-pipe is of 12in. diameter, and is made of cast iron. The connections from the two engines are 5in. diameter. Peet's valves, 12in. and 5in. diameter, are used in the exhaust system. At present no condensing arrangements are provided, and the exhaust steam is discharged into the atmosphere.

THE ENGINES.

These have been supplied by Messrs. Willans and Robinson, of Thames Ditton, and are of their noted high-speed central-valve type. They are of the GGG S size, compound, and run at a speed of 450 revolutions per minute. Each engine has three cranks placed at angles of 120deg. The low-pressure cylinders are 14in. in diameter, and the high-pressure 10in. The stroke is 6in. The engines are normally to give 110 b.h.p. to 115 b.h.p., but they are capable of doing about 135 b.h.p. at a push at the normal steam pressure of 150lb. above the atmosphere. A general view of these engines coupled to the alternator is shown in Fig. 7.

THE ALTERNATOR AND EXCITERS.

The alternators are of the Johnson and Phillips new type, having revolving field magnets and stationary armatures. The field magnets consist of two similar steel castings mounted on the spindle. Each casting has a series of nine poles projecting inwards, so that when the two are bolted together a series of 18 alternate poles is obtained. The excitation is provided by a single coil placed on the inner cylindrical part of these castings. The elevation of this machine attached to the Willans engine is shown in Figs. 8 and 9, but the details of construction can better be seen from

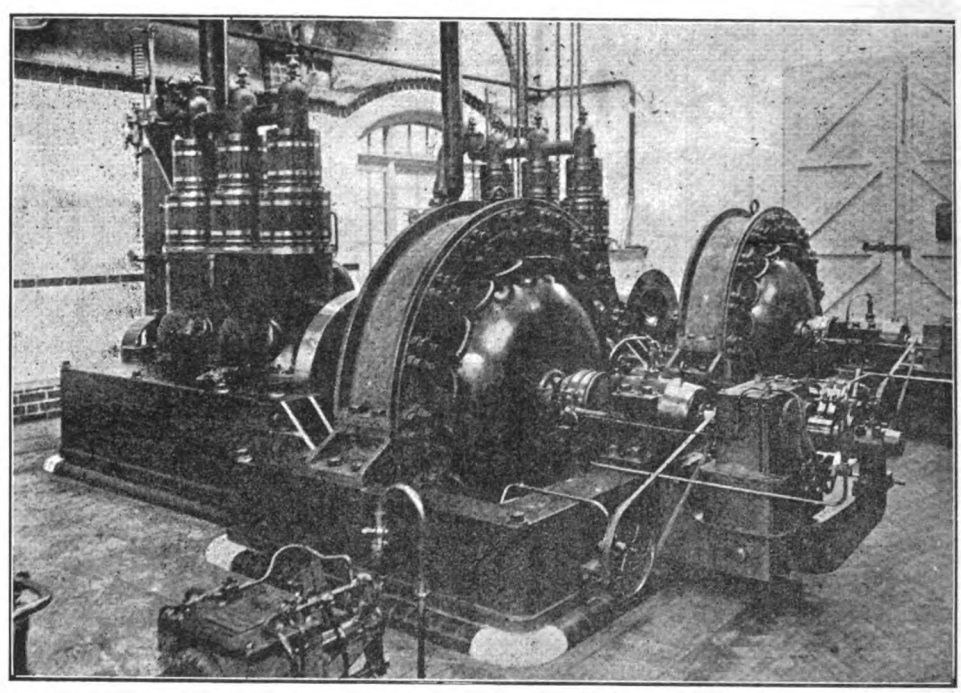
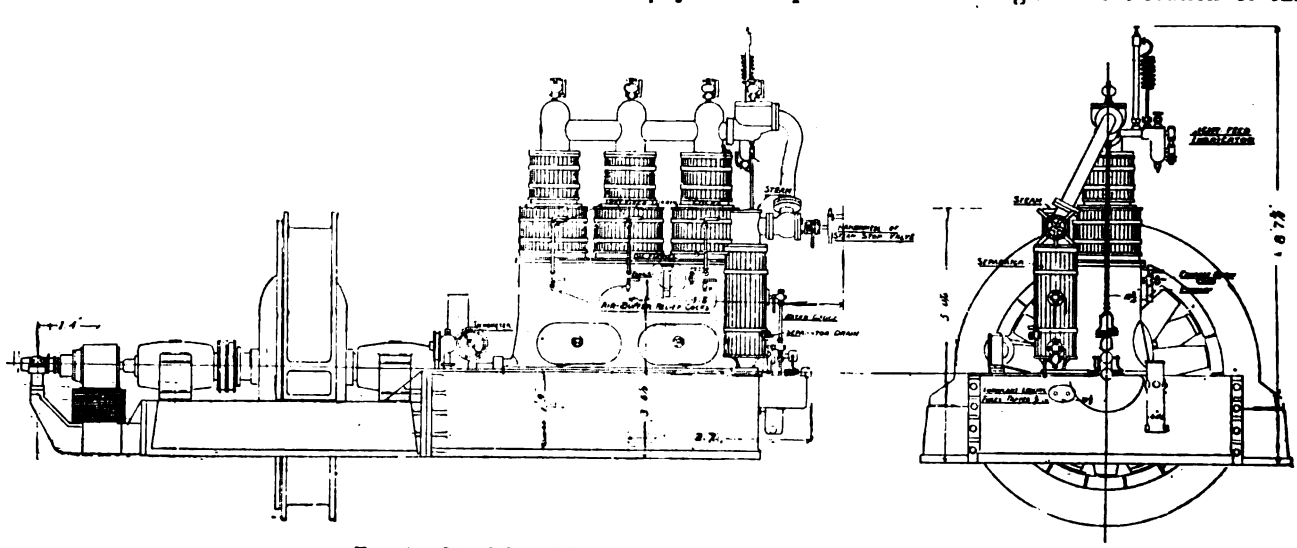


FIG. 7.—View of the Two 75-K.W. Steam Alternators.



FIGS. 8 and 9.—Side and End Elevation of 75-K.W. Steam Alternator.

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the general view, Fig. 10. The armature frame consists of a cast-iron ring, to which are bolted the segments. The coil round each segment is wound on a frame of the correct shape, and carefully insulated. Then the thin iron plates forming the core are inserted one by one until the required section is obtained. They are then clamped by bolts passing through the end plates (seen in the perspective view). A complete and readily interchangeable segment is thus obtained, which can be bolted in position on the frame in a very short time. The complete envelope of insulation round the armature wires gives a very high insulation resistance. The exciters are placed on the prolongation of the armature shaft, as shown in Fig. 10, and the field magnets of these shunt exciters are supported on a bracket bolted to the bedplate. A continuous flow of oil through the bearings is automatically provided by means of a small circulating pump driven by a belt from the shaft. There are at present in use two of these alternators, capable of giving 36 amperes at a pressure of 2,100 volts, the speed being 450 revolutions per minute, gives a frequency of

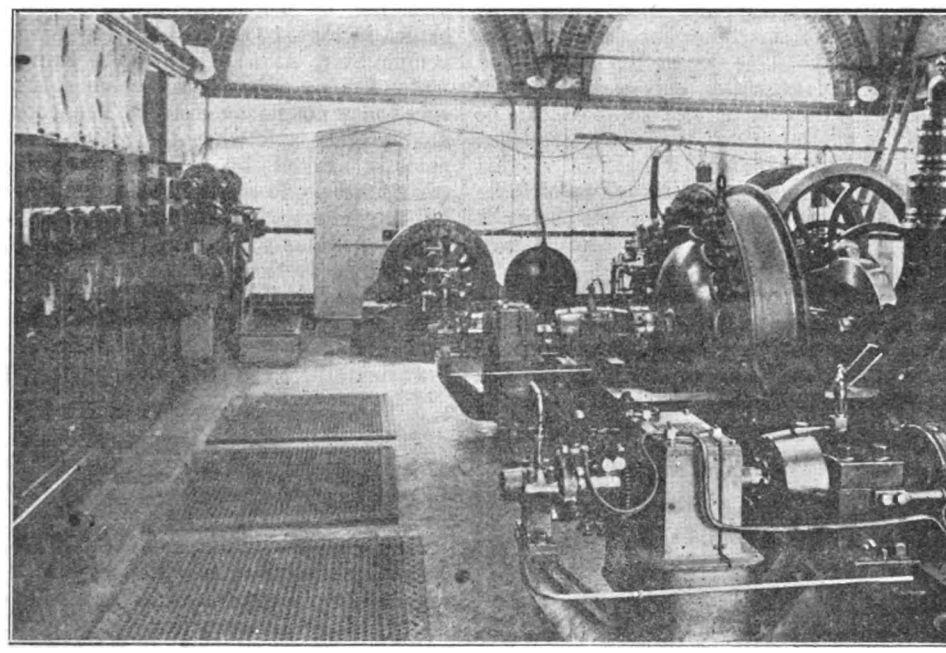

FIG. 10.—View of Engine-room.

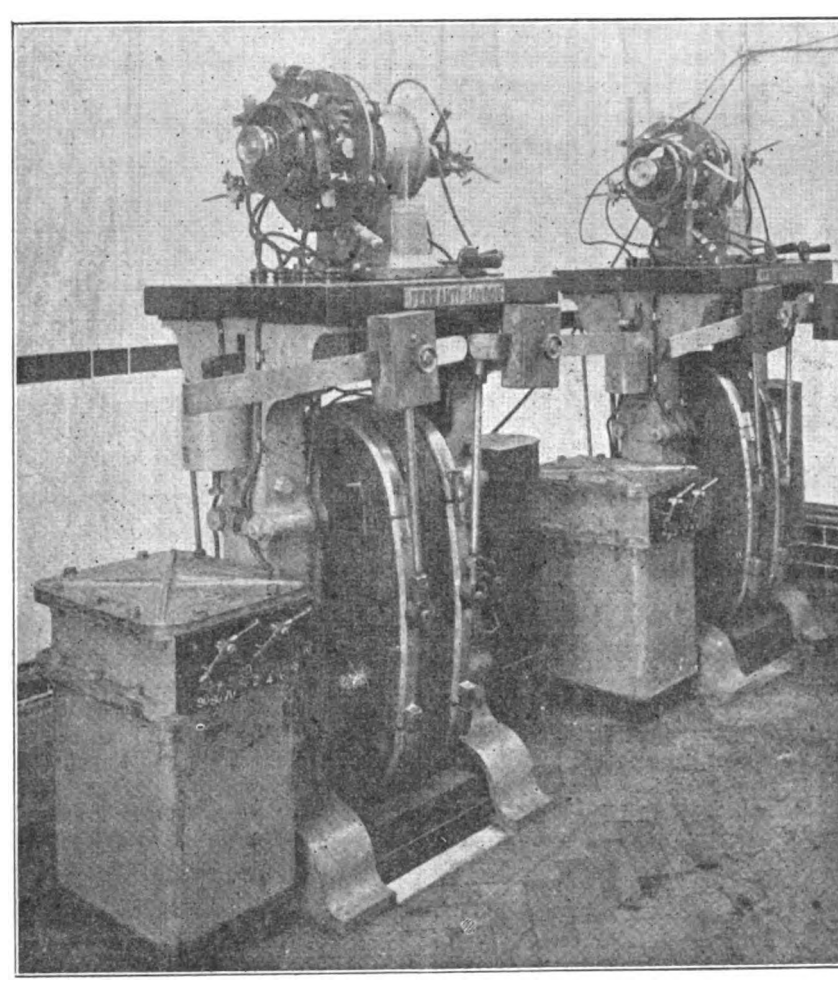

FIG. 11.—View of Rectifying Plant.

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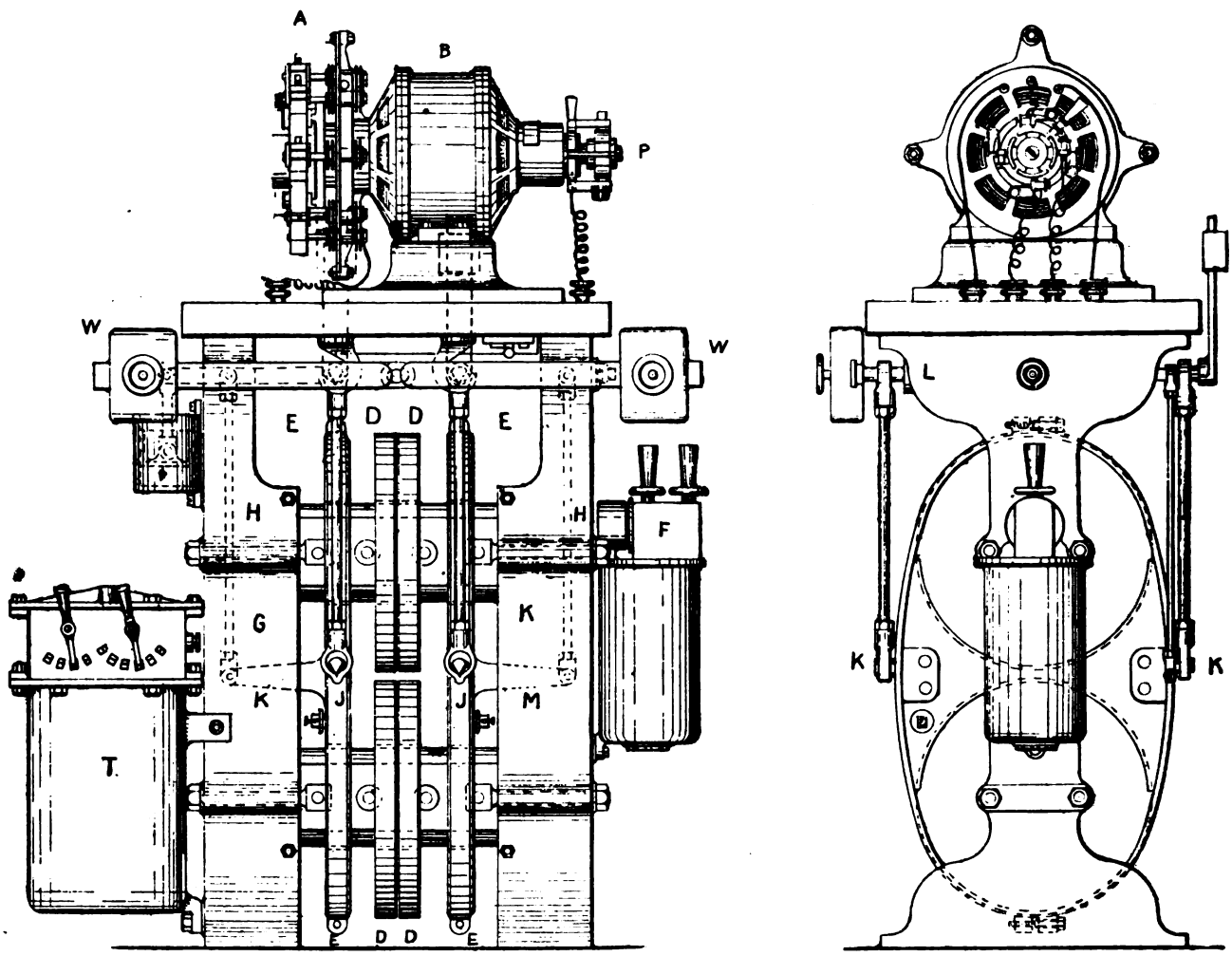
68. The smaller alternator is driven at 580 revolutions by the gas-engine, and is rated up to 15 kilowatts.

Ferranti Rectifiers.

The arc lighting system is supplied with current by the now well-known Ferranti machines for rectifying the alternating current required. This system has as its main advantage that one type of generator only is required in the station, and hence the number of sets supplied can be reduced. For instance, at Tunbridge Wells, were rectified currents not employed, arc dynamos would be needed to give the high-voltage continuous current. Two of these arc machines would be required at first, one being a stand-by. Then when the supply is given continuously throughout the night, as required by the Board of Trade, two engines would have to be running—one to supply the arc lights, and one alternator to supply the very small demand for private lighting. With the present arrangement one alternator will be able to supply both the arc and incandescent lighting at such times, and the two together will provide an economic load for the set. This shows a distinct advantage over running two sets at light loads, at which the engines do not give economic results. The rectifiers, however, at present require special attention, which somewhat raises the cost of supervision.



Figs. 12 and 13.—Details of Ferranti 25-light Rectifiers.

Fig. 11 shows the two 25-light rectifiers in use at Tunbridge Wells. The details will be seen from it, and from Figs. 12 and 13, which show two views of one of the sets. The main principle of the apparatus is simple, but various details required most careful attention to ensure a commercial apparatus. The first *sine qud non* is a truly synchronous motor to drive the commutator, and it is the failure of the motor to follow the variations in speed of badly-governed engines that has caused the majority of trouble found with these rectifying apparatuses. The next interesting feature is the regulating gear. Instead of rectifying at constant potential, and then regulating the arc lighting current by resistances to equalise any unevenness in the burning of the lamps, the regulation is effected by altering the voltage supplied to the commutator by means of a constant-current transformer. The contractors guaranteed that the variation of current when one lamp was extinguished in the circuit should not, at Tunbridge Wells, be more than ·06 of an ampere. The details of construction by which the above effects are obtained are shown in Figs. 12 and 13. The six-segment but two-part commutator, A, is driven by a Brown motor, B. This motor has six poles in its revolving part in order that the speed may not be excessive. The rotor is practically the field magnet, and when the motor is in synchronism this field is excited by a current rectified by the small commutator. In starting, this revolving part is energised by the alternating current, so that the speed rapidly rises to a value slightly above the speed of synchronism. The motor is then run as an ordinary shunt motor, a resistance being introduced into the field circuit. On attaining synchronism the resistance is cut out, and the field excited through its commutator from a few turns off the armature. The two-unit converter, T, is provided with connections to various windings, so that the motor can be supplied with any voltage from 60 to 100 to suit the conditions of the circuit. The main commutator, A, is overhung, and is built in two parts, each half carrying three segments. The parts in the commutator are varied with the periodicity employed, the number of segments increasing with the frequency, so that the time of commutation is approximately a constant for each design. The two halves of the commutator are securely interlocked on coned ebonite bushes mounted on a steel sleeve, so that the whole commutator can be removed from the motor spindle with the utmost ease. Separately insulated strips of copper are interposed in the air-gaps, between segments, for the purpose of mechanically breaking up the arc and thus preventing destructive sparking.

We now come to the constant-current converter. This apparatus consists of a closed-circuit iron core, C, with four fixed secondary coils, D D, and four swinging primary coils, E E. A water-break switch, F, is inserted in the primary circuit, and a dash-pot, G, is provided for steadying the motion of the primary coils. The constant-current

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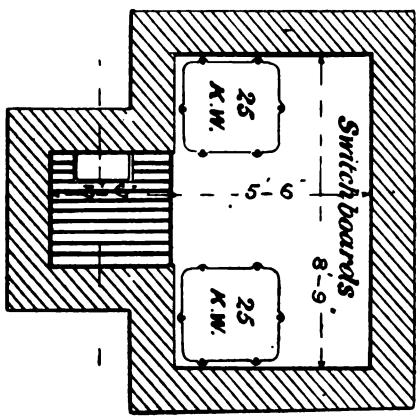
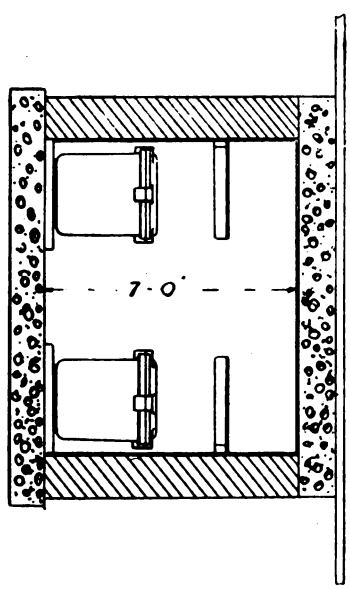
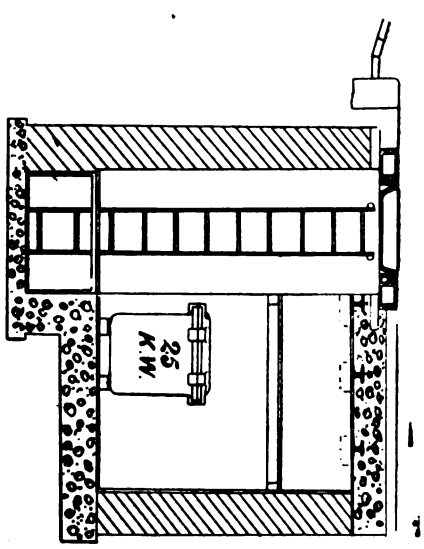
converter depends on the action of magnetic leakage on the transforming ratio of the transformer. The primary and secondary coils as arranged repel each other with a force varying with the strength of the current. The primary coils being free to move are thus repelled outwards against







FIGS. 23, 24, AND 25.—Details of Transformer Sub-Stations.

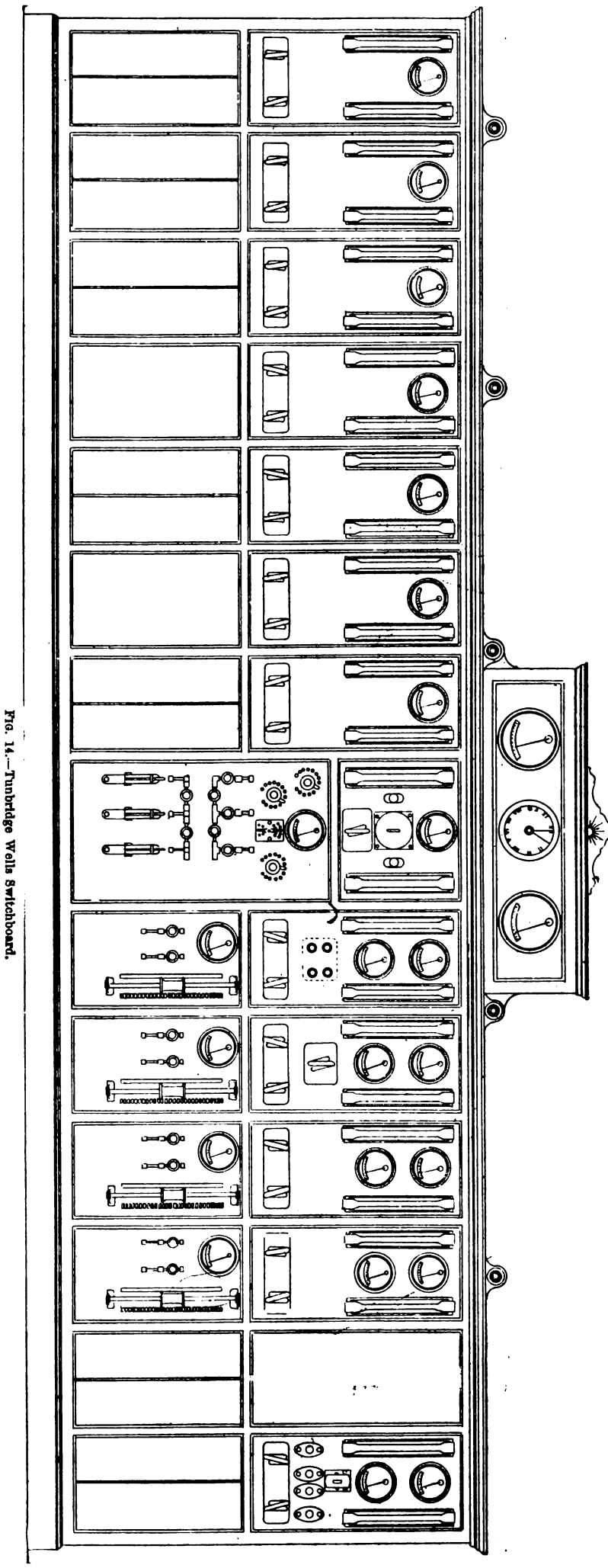


FIG. 14.—Tunbridge Wells Switchboard.

the restraining influence of the weights, W W. When these coils move further away the magnetic leakage increases, and hence the transforming ratio is reduced. The weights, being movable on the levers, can be adjusted to give any desired current for the normal position of the primary coils, and then a considerable alteration in the number of lamps burning can be made without altering the value of the current appreciably.

(Continued on page 396)

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MUNICIPAL ELECTRICAL ENGINEERS.

We really must protest against the attempt to impute personality to us—we have attempted to deal with a principle, not with a person. If it will serve any good purpose, we are willing to admit that Mr. Madgen is an ideal man for an organising secretary; that he is an ideal man in energetically pushing business. We have nothing to say against Mr. Madgen in any capacity except as secretary *pro tem.* to organise an association with many, if not most, of the members of which he has business relations. The statement of Mr. Wordingham, that municipal electrical engineers have not much time to spare, we fully endorse—but that is not the point. What we want to see is an association against which no objection can be raised from any quarter; and, as may be gathered from the course of events, we are, more or less, the mouthpiece of those who see objections, of those who are in a position to be members of an association and who desire to be members. It is not a pleasant duty to pull nuts out of the fire for other people, but it is a necessary one on occasions.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

MUNICIPAL ELECTRICAL ENGINEERS.

Sir,—The committee who were appointed to draw up a scheme for the formation of a Municipal Electrical Association have read with much surprise your article in the *Electrical Engineer* of the 20th ult. Without commenting on the language which you have seen fit to use with regard to individuals, the committee think that it would be well to put you in possession of the facts relating to the matter, and they have desired me, as secretary to the first meeting that was held, to forward you a copy of the report of that meeting which I drew up at the time. From this you will perceive that the committee is composed exclusively of municipal electrical engineers, who, I think you will acknowledge, are free from any of the objections which you have enumerated in your article. It is a fact—although from the depreciatory manner in which you refer to them it may be a matter of surprise to you—that municipal electrical engineers are busy men, and have little time to devote to secretarial work: they therefore invited Mr. Madgen to undertake this work during the formation of the society. From the report, you will see that Mr. Madgen was only temporarily appointed, and the committee could obviously not appoint officers to a society which does not yet exist, their functions merely relating to the preparation of a draft constitution which is to be submitted to a meeting of municipal electrical engineers to be called later on. The officers of the society, when formed, will be elected according to the constitution approved at the meeting referred to.

No secrecy has been observed in the matter, a copy of the report which accompanies this having been forwarded to each engineer who was present at the meeting of July 8, 1895. All these engineers being duly accredited by their respective corporations to represent them at a discussion of the new Board of Trade rules, the committee was thoroughly representative in every way.—Yours, etc.,

C. H. Wordingham.

Manchester, October 2, 1895.

[Copy.]

Proposed Municipal Electrical Association.

At the meeting of the municipal electrical engineers to discuss the new Board of Trade rules held in Westminster on Monday, July 8, 1895, the subject of the formation of an association of municipal engineers was brought forward

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by Mr. Rider, of Bolton, and was very warmly approved by the meeting. It was decided to appoint a working committee of five engineers to draw up the constitution of the proposed society, and to prepare a draft set of rules. The following gentlemen were elected by ballot: A. S. Baynes, A. B. Mountain, J. H. Rider, C. H. Wordingham, and A. Wright.

This committee held a meeting on the following day and appointed Mr. W. Madgen hon. secretary *pro tem.* Mr. Madgen having expressed his willingness to act, it was felt by the committee that his services would be of great value to them, he being thoroughly in touch with most of the central-station engineers in the kingdom, and having taken a very keen interest in the subject, being, in fact, the originator of the movement.

The main lines on which the association should be formed were practically settled, and a draft scheme will very shortly be prepared.

(Signed) C. H. WORDINGHAM,
Secretary of Meeting.

TELEPHONES AND THE BRITISH ASSOCIATION.

SIR,—The propriety of the contrast which I drew in my British Association paper between the telephonic conditions of Dorset and the Grand Duchy of Luxemburg has been challenged by one of your contemporaries—the *Electrical Review*—on the ground that, although Dorset is, as I stated, practically destitute of telephones, their absence is compensated for by the existence of a telegraphic network, which, from a map given by your contemporary, appears to comprise 73 stations, the suggestion being that Luxemburg is deficient in telegraphic, as distinguished from telephonic, facilities. The logic is somewhat of the horse-chesnut and chesnut-horse order, it being apparently assumed that because the telephone has been declared a telegraph by the Post Office the telegraph must necessarily be a telephone, and that the two inventions are interchangeable for practical purposes. This is a cherished illusion in some quarters, but is an illusion still.

But what are the facts regarding Luxemburg and Dorset? As I write I have before me the report for 1892-3 of the Minister of Posts and Telegraphs of the Grand Duchy. At page 2 the number of telegraph stations is stated to be 113. Now let me compare the facilities, both telegraphic and telephonic, respectively enjoyed by these two districts—equal in area and population.

Telegraph Alone.

Dorset: telegraph stations in 1895	73
Luxemburg: telegraph stations in 1893	113
Public telephone stations (used also as telegraph offices) in localities unprovided with exchanges, in 1894	26
	139

Balance in favour of Luxemburg, 66 telegraph stations. The total represents almost double the number possessed by Dorset. In addition, *all* the Luxemburg telephone exchanges are in connection with the telegraph system, and so may be counted as telegraph offices too.

Telegraph and Telephone Combined.

Dorset: telegraph stations in 1895	73
Telephone exchanges in 1895	3
	76
Luxemburg: telegraph stations in 1893	113
Telephone exchanges in 1894	59
Public telephone stations, as above	26
	198

Balance in favour of Luxemburg, 122. That is to say, the Luxemburg *excess* is almost double the Dorsetshire total. Another point:

Telegraph offices in Luxemburg open day and night	3
,, ,, ,, Dorset ,, ,, ,, ,,	0

And yet we Britons are continually being told by our Post Office that we possess the best telegraph system in the world—so good, indeed, that telephones are almost superfluous!

The following additional contrast, suggested by the meeting place of the association, is of interest:

	Population.	Number of exchange telephones.	Number of persons to each exchange telephone.
Ipswich	61,000	150	407
Helsingfors	65,000	2,150	30

The *Electrical Review* also deplores the fact that I confined my comparisons to Europe, and did not include the United States and New Zealand, both of which, it says, would have been entitled to rank in Group I., while their characteristics of management would not have lent colour to my deductions. The first assertion I admit; the second I traverse. To prove that two countries besides those I named are entitled to rank ahead of it, is a singular way of demonstrating the sufficiency of the telephone service of the United Kingdom. But no matter: that is simply an outcome of the *Review's* peculiar system of logic. I could not have gone outside Europe without including *all* extra-European countries, which was impracticable. Had I chosen two good examples, like New Zealand and the United States, the *Review* would probably have said: "Unfair and misleading! How about Kerguelen Land and Tristan d'Acunha?" Those who care to read the evidence given before the late Select Committee on the Telephone Service by the Postmaster-General of New Zealand, will perceive that at least two of the characteristics of management in that colony are quite opposed to those in force at home, while they coincide with the conditions which prevail in the countries composing my Group I.: (1) Low rates—*i.e.*, £5 per annum. Question 4,064: (2) Good country intercourse. Question 4,058: "We are a very scattered community in New Zealand, and there is a great number of places outside those exchanges I have named where there are telephone exchanges not included in these lists at all. There are scores of small places. Practically, our telephone service in the smaller parts of the country we look upon as auxiliary to the telegraph service."

As regards the United States, the rates have hitherto been high in most cases, and there has not been much competition, but there has been (1) local management in each town by a company dependent on its exertions for a livelihood, and (2) good country intercourse; so that two of my requirements are again fulfilled.

In its character of apologist-in-chief for high rates, monopoly, and inefficiency, the *Review* makes one or two other assertions which may possibly mislead the uninstructed, but which consideration for your space compels me to leave unanswered.—Yours, etc., A. R. BENNETT.

22, St. Alban's-road, Harlesden, N.W.

ELECTRIC TRACTION.

SIR,—I notice a misprint in the table belonging to Mr. Dawson's paper on page 371 of your last issue which is perhaps worth correction, inasmuch as the "car density per mile of track" is sometimes used as a more or less incomplete criterion of respective tramway systems. The Rouen lines have a total length of 25 miles, not 20; and there will be 50 motor cars, instead of 10. The horse-power available at first will be 750, not 900—there being three sets of belt-connected generators each of 175-kilowatt capacity. I think the figures relating to motor cars at Rouen and Pessac must have got interchanged in the table, as I can hardly imagine a line 3½ miles long with *50* motor cars and *300* h.p. only in the power-house. The mistake is not to be wondered at altogether: British Association papers are generally as full of misprints as an egg is full of meat.—Yours, etc., FRANK B. LEA.

Rouen, September 25, 1895.

Shunt Motors with Variable Speed.—Herr F. A. Wessel describes in the *Elektrotechnische Zeitschrift* of September 26 an arrangement which, he says, very simply and very efficiently enables electromotors to be run at variable speeds. The apparatus consists of a shunt motor with two collectors, which is connected with the Wessel-Egger reversing apparatus. The latter has hitherto only been used with constant speeds, but it has now been combined by the author with a regulating apparatus, which permits the revolutions of the motor to be varied as much as fourfold, and the rotary direction to be reversed.

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TUNBRIDGE WELLS ELECTRICITY WORKS.

(Continued from page 393.)

The secondary pressure before reaching the commutator is thus kept proportional to the number of lamps in circuit. The four primary coils are coupled together in pairs, being held in position by teak coil carriers supported by split German-silver bands, J J. The coils are swung on knife-edges, K K, from cross-bars, L L, which also rest on knife-edged seats, M M, suspended from the slate base. The links, H, and arms, M, keep the coils vertical by giving a parallel motion. The secondary coils are firmly fixed on the core. Great attention is paid to the insulation of both primary and secondary.

Each rectifier is provided with pole indicator, quick-break reversing switch, and interchangeable plugs for switching either rectifier on to circuit. The arc lamps fed by these rectifiers are of the Brockie-Pell type, and were supplied by Messrs. Johnson and Phillips. The lamp-posts were cast by Messrs. Macfarlane and Co., of Glasgow.

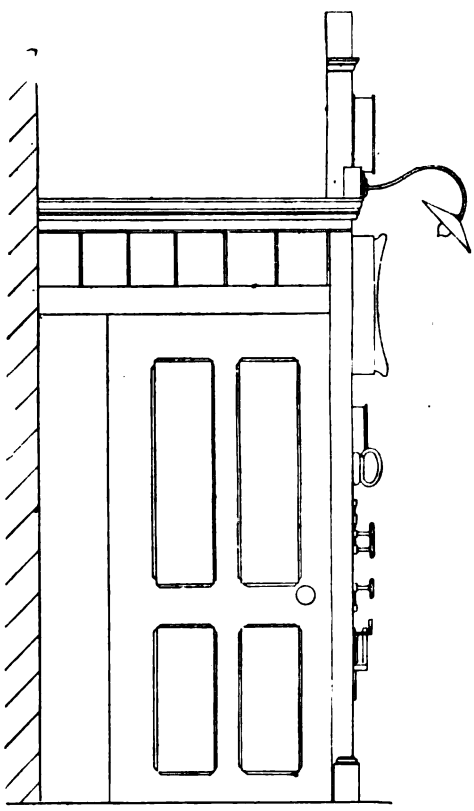

FIG. 15.—Side Elevation of Switchboard.

FIGS. 16 AND 16A.—Details of Plug Switch.

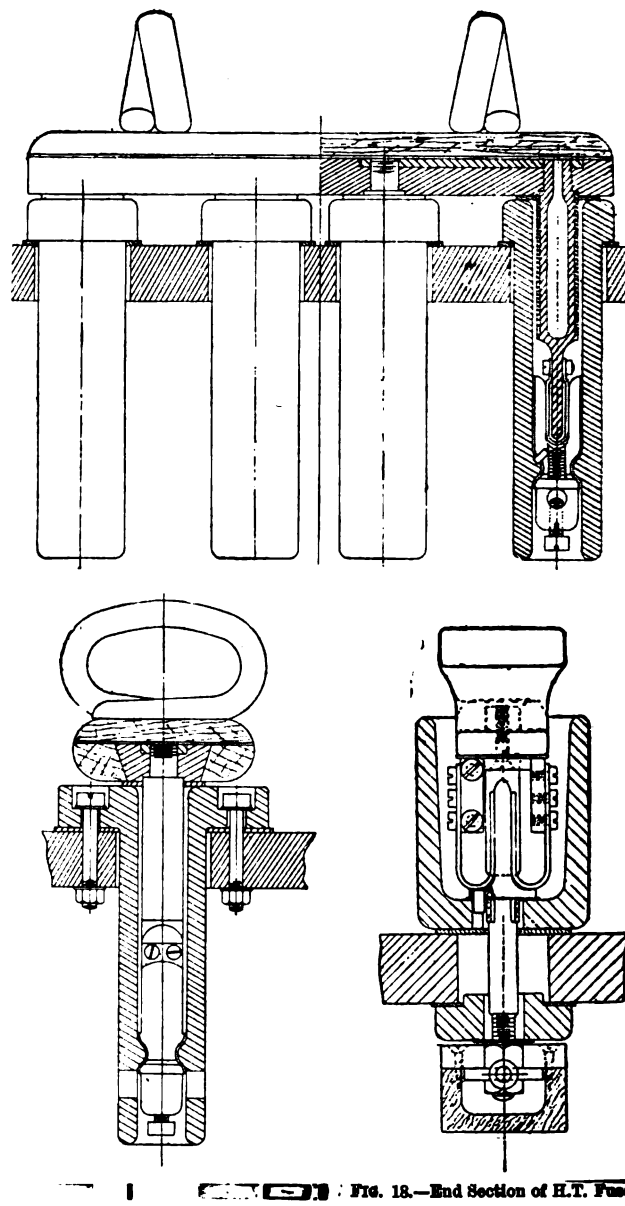

FIG. 18.—End Section of H.T. Fuse

one arc light circuit and two rectifiers. It is also designed for running the alternators in parallel, and is provided with the necessary synchronising gear. On the right-hand side of the switchboard are the three panels belonging to the alternators. Considering one of these panels only, the

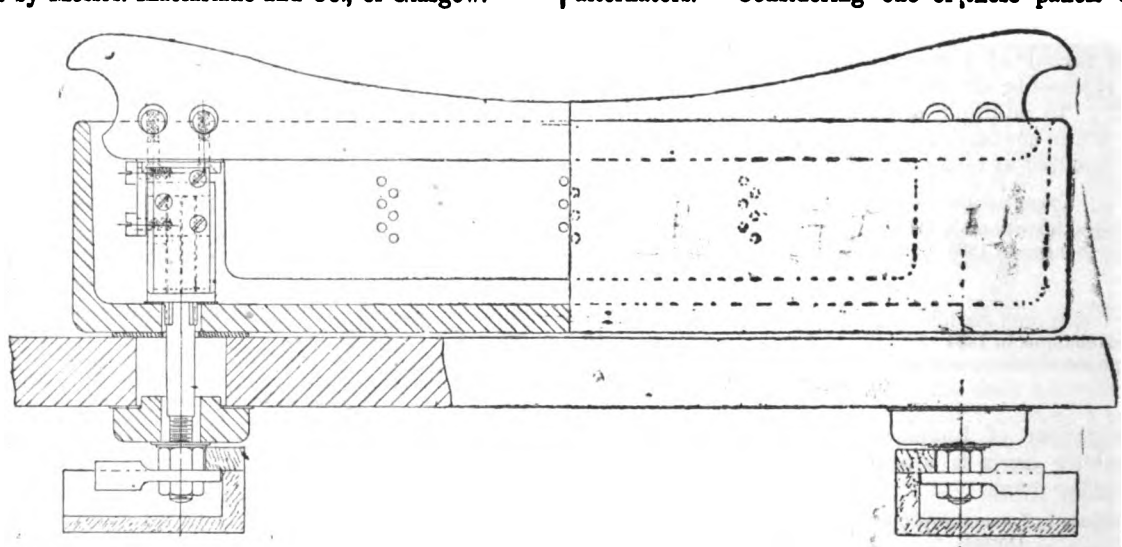

FIG. 17.—Elevation of High-Tension Fuse.

SWITCHBOARDS.

In this switchboard (Fig. 14 and 15), which was manufactured by Messrs. Crompton and Co., provision is made for three alternators and exciters and four main circuits; also for leads from the alternator are brought firstly to a pair of high-tension fuses mounted in stoneware, then through the ampere-meter to the high-tension double-pole four-break plug switch, also encased in stoneware. From these the

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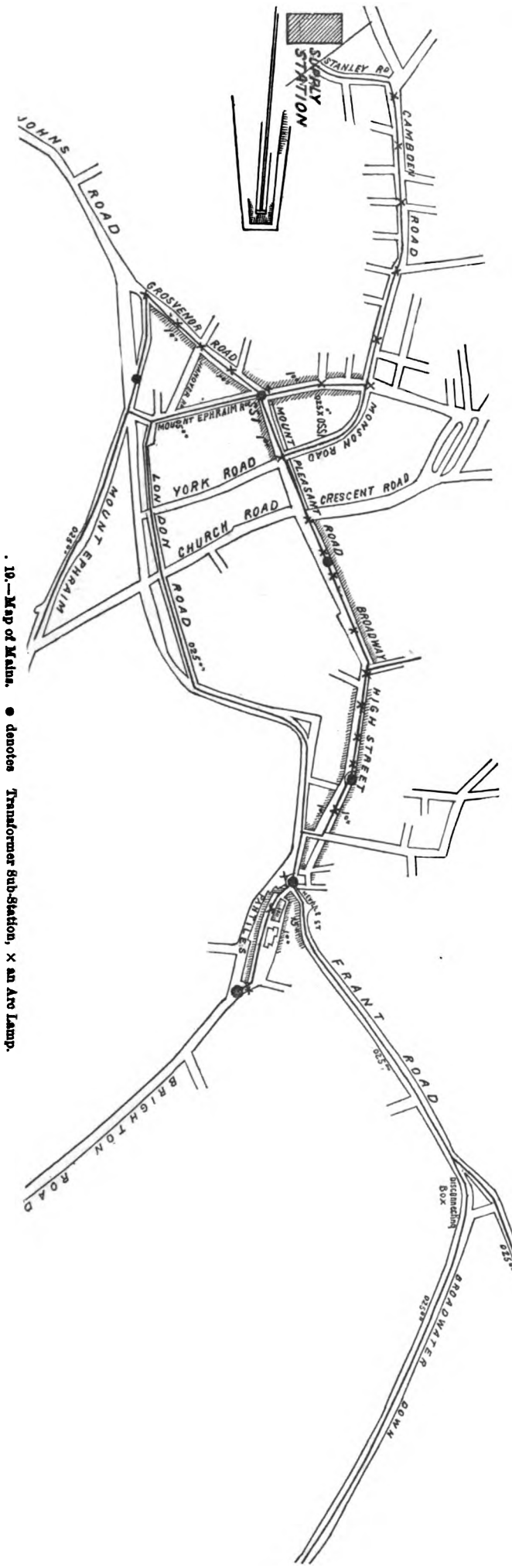

Fig. 19.—Map of Mains. ● denotes Transformer Sub-Station, × an Arc Lamp.

connections pass to the 'bus cables at the back of the board. Below the ampere-meter is placed the electrostatic voltmeter measuring the E.M.F. of the alternator without a reducing transformer. Below the panel containing the above apparatus is placed another containing an ampere-meter regulating switch and double-pole main switches and fuses in the exciting circuit of the corresponding alternator. On the left-hand side of the centre of the board are placed the four circuit panels, each provided with double-pole fuses, ampere-meter, and high-tension plug switch, just as for the alternators.

The current is brought from the 'bus cables at the back of the board, first through the plug switch, then through the fuses, and thence to the circuit through the ampere-meter. Between the alternator and circuit panel in the centre of the board is fixed a panel containing the double-pole exciter switches and fuses and the automatic knock-off switches for same. Three shunt regulating switches are provided for varying the E.M.F. of the exciters when throwing them into parallel; also a three-way voltmeter switch in connection with the voltmeter, so that the E.M.F. of any of the exciters may be measured. Above this panel is placed another containing the synchronising apparatus, and the high-tension electrostatic voltmeter and three-way voltmeter switch for measuring the E.M.F. of the pilot wires. Above the centre of the whole switchboard are placed a main ampere-meter, electrostatic voltmeter, and clock, the two former being connected to the 'bus cables. On the extreme right of the switchboard is situated the panel for the arc light circuit by means of rectifiers. On this panel provision is made for one circuit and two rectifiers. The leads from each rectifier are brought to the sockets of the double-pole four-break plug switch, and from thence are connected by means of the plug switch to a pair of fuses, and thence pass away to the arc light circuit through the ampere-meter. Below the ampere-meter is placed an electrostatic voltmeter measuring the E.M.F. of the circuit, and also a three-way voltmeter switch, so that the E.M.F. of the rectifier can be ascertained before plugging it to the circuit. By providing only one plug for the two sets of sockets, it is not possible to put both rectifiers on to the circuit at the same time.

The panels are of enamelled slate, 1½in. thick, fixed in a suitable varnished teak frame, the joints being covered with a varnished beading.

The whole of the switches are of the plug type, Fig. 16. The sockets for these are entirely encased in stoneware tubes, and are sunk very deeply in the board so that it is impossible to get a shock from them from the front of the switchboard. The plugs are mounted on an ebonite base set in a wood foundation, and are provided with suitable handles. The plugs themselves are also encased in ebonite, with the exception of the flat spring contacts at the end, so that it is impossible to get a shock when a plug is only partly withdrawn from its sockets. As the sockets extend over the metal at the back, they are also a protection at the back of the board.

The fuses (Figs. 17 and 18) are entirely mounted and encased in stoneware, and consist of a pair of clips, between which a porcelain bridge is inserted provided with terminals at the top and bottom. The fuse-wire is connected to these terminals, and threaded in and out through holes in the porcelain bridge so as to prevent any possibility of an arc forming from one terminal to the other on the fuse breaking.

The ampere-meters are of Messrs. Crompton and Co.'s manufacture, and are of the electromagnetic type, the dials being 8in. diameter, with the exception of the main ampere-meter at the top of the board, the dial of which is 12in. in diameter. In all cases the terminals are carried through the back of the instruments, and are encased in ebonite.

The high-pressure voltmeters are of the electrostatic type, and the low-tension voltmeters for the exciters are of the electromagnetic type, being also of Messrs. Crompton and Co.'s manufacture.

A synchroniser is provided at the back of the board, mounted on brackets and fitted with usual double-pole high-tension fuses. This synchroniser is connected by means of a pair of single-pole plugs to the 'bus cables, and is also connected to a pair of small 'bus cables, which are connected to a set of sockets on each alternator panel, and also to a double-pole plug switch on the synchroniser panel. A pair of plugs—one for the alternator and one for the

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synchroniser panel—are provided to connect an alternator first to one side of the synchroniser by means of its plug switch on its own panel, and then when the machine is in phase it can be connected to the 'bus cable through a pair of light fuses, situated on the synchroniser panel, by means of a small plug switch on the same panel. After this is done, the alternator would be again connected to the 'bus bar by means of its own main switch. As only one plug is provided for the alternators, and as it is of a different size to that for the synchroniser panel, it is not possible to connect two alternators to the synchronising 'bus cables at the same time. The whole of the necessary plug and socket work for the above apparatus is mounted in ebonite.

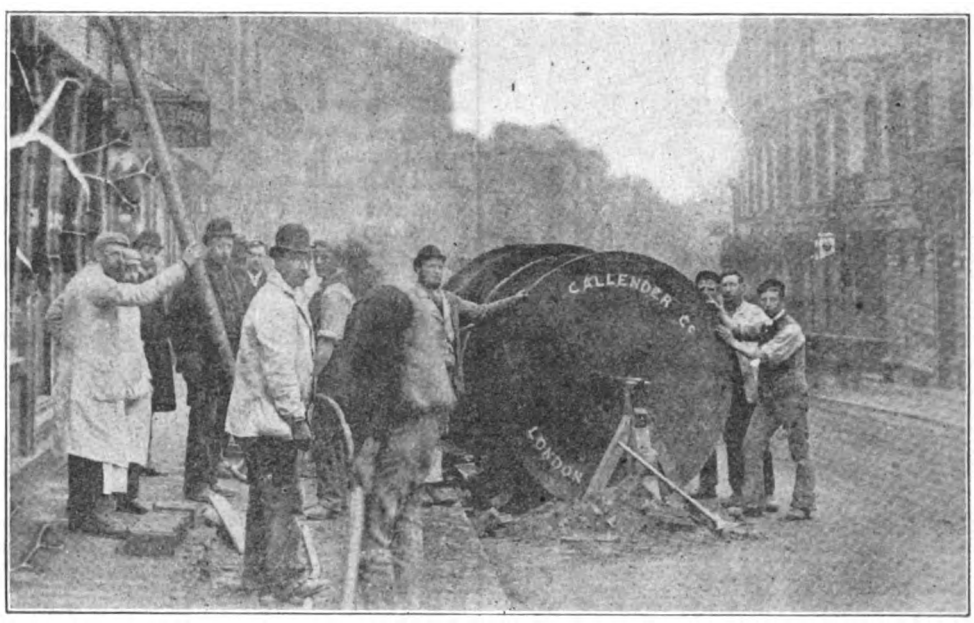

FIG. 20.—Laying Mains at Tunbridge Wells.

The exciting switches and fuses are of the usual low-tension pattern, the fuses being strips of fusible metal held between copper terminals, and the switches are of Messrs. Crompton's copper-foil S pattern. The three shunt regulating switches are of the circular pattern. The resistances for the same are mounted at the back of the board, and consist of platinoid coils wound on suitably insulated frames. The magnetic knock-off switches are of the usual type, and arranged so that upon the current falling to a minimum through the failing of an exciter or other causes, they automatically break circuit, thereby preventing any possibility of a return on the machine.

The slate panels are left bare at the back of the board, so that the terminals can be easily got at, but the whole of these terminals are suitably protected. In all cases where the high-tension connections pass through to the back of the board, they pass through quite clear of the slate or their ebonite or stoneware bushes, and no high-tension metal work is at any spot in contact with the slate. The connections at the back of the board are made by means of heavily insulated rubber cable. The resistances for the alternator field circuits are also mounted at the back of the board, and are constructed of platinoid wire wound on suitable frames similar to those for the shunts of the exciters.

Extensions are allowed for, so that an additional alternator can at any time easily be added by adding another panel to the right-hand side of the board. In the same way additional circuits can be provided for by adding panels at the left-hand end of the board, or if length is an object a second set of panels can be placed below the first. For additional synchronising apparatus, room is provided on the alternator panels. Spare panels for two alternators and exciters and three circuits are provided fixed in position ready to receive the necessary instruments and fuses.

MAINS AND DISTRIBUTING GEAR.

The distribution is on the high-tension system, the current being supplied direct from the generating station in Stanley-road to seven sub-stations through four high-pressure feeders and three sub-feeders. The system of supply will vary with the locality. A large proportion of the town consists of residential districts, containing gentlemen's houses standing in their own grounds. As a consequence, a large number of consumers will be found in outlying districts, where a low-tension system will not be at all economical for some time. In such cases a transformer will be placed in the houses. In the streets of the town low-tension distributing mains are being laid down wherever the demand is found sufficient. In the map of mains already laid, Fig. 19, the sub-stations are indicated by circles and the arc lamps by crosses in the streets. Also the lines indicate high-tension mains only, the low-tension distributors occur wherever the sides of the streets are cross-hatched. There is also an arc-light circuit laid throughout the chief streets of the town. The whole of the cables for the high-pressure feeders, low-pressure distributors, and arc-light mains have been manufactured and laid by the Callender Bitumen Telegraph and Waterproof Company, Limited, whose engineer on the work was Mr. H. Y. Schiassi. The type of cables employed throughout the

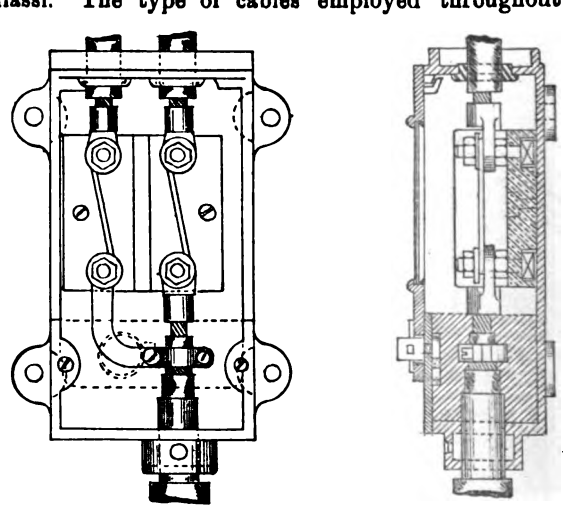

FIG. 21.—Reid's House Fuse Box.

whole of Tunbridge Wells is concentric, lead-sheathed, and armoured, and have conductors of the following sectional areas and lengths:

Feeder A, together with sub-feeder A, has an area of ·025 square inch, and is 1,817 yards in length. It runs from electric light station through sub-station 1 at the junction of Calverley-road and Mount Pleasant, thence *vid* Grosvenor-road to the Mount Ephraim sub-station. Feeder B, of ·035 square inch sectional area, is 1,800 yards

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in length, and goes from electric light station to the sub-station 3 in High-street. Feeder C, also ·035 square inch, is 2,410 yards in length, and runs *vid* High-street, looping into sub-station 3, and thence *vid* the Pantiles to the sub-station at north end of the same, opposite to the pump-room. Feeder D runs from electric light station through sub-station 1, thence down Mount Ephraim-road and laid in 1895, together with their respective sizes, are as follow: ·025, 6,874 yards; ·035, 5,362 yards; 050, 1,350 yards; ·022, 3,796 yards; ·10, 2,781 yards; ·15, 1,175 yards; ·20, 85 yards. This gives a total length of about 12¼ miles, and it is a credit to Mr. Schiassi that this length has been successfully laid since January last. A view of the work in progress is shown in Fig. 20.

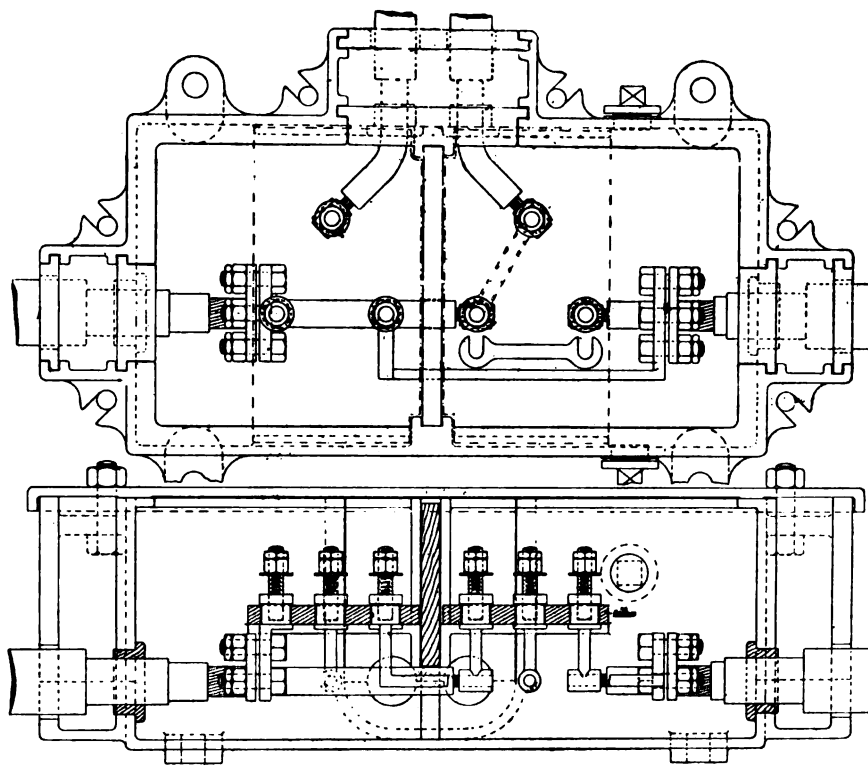

FIG. 22.—Transformer Connecting Box.

to the junction of London-road; this is 1,350 yards in length, and ·05 square inch sectional area. Sub-feeder D_2, ·025 square inch, is 1,170 yards in length, and runs from the junction of Mount Ephraim-road and London-road (where D ends) *vid* London-road to the transformer-chamber in Neville-street. Sub-feeder D_1, also ·025 square inch, is 860 yards in length, and is also run from where D

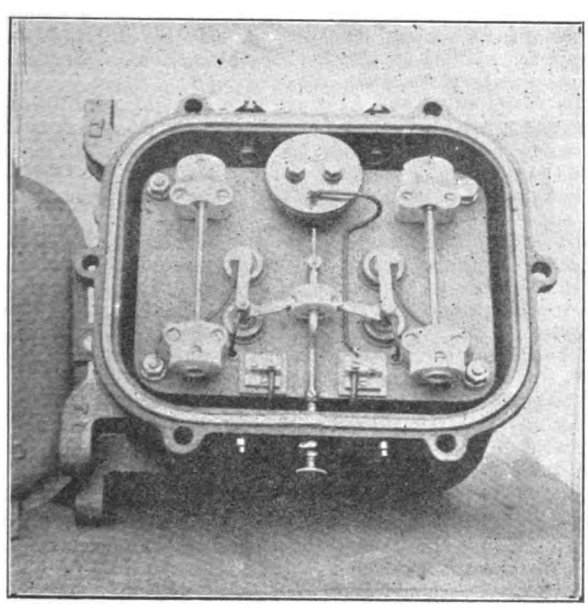

FIG. 26.—Crompton Transformer.

ends in Mount Ephraim-road along Mount Ephraim as far as the Mount Ephraim House. The arc lighting cables have a uniform area of ·022 square inch. At present only one circuit is used. The low-pressure distributing mains vary from ·10 square inch up to ·15 square inch and ·25 square inch sectional area.

The total amount of cable supplied to Tunbridge Wells,

House services are also laid on with concentric cable, lead-sheathed and armoured. These cables are of four sizes—*i.e.*, $^{7}/_{16}$, $^{7}/_{14}$, $^{19}/_{16}$, $^{19}/_{14}$—the services being joined to the mains in cast-iron boxes. The house ends terminate in Reid's fuse-boxes, as shown in Fig. 21. The cables, after being inserted in the box, are cast in with insulating compound to prevent the damp from running back up the cable. The transformer connecting boxes are shown in Fig. 22.

TRANSFORMER SUB-STATIONS.

These are excavated chambers under the footways of the general shape shown in Fig. 23, 24, and 25. The details vary somewhat with the space available.

The transformers (Fig. 26) were supplied by Messrs. Crompton and Co., and consist of a rectangular iron core with two coils wound on the two longer sides of the rectangle. Each coil has both a primary and a secondary winding, the primary winding being nearest the core. The insulation between these two windings and between the primary winding and the core consists largely of mica. These transformers are placed in cast-iron water-tight cases, fitted with a special type of water-tight gland bushed with stoneware bushes. The terminals are mounted on stoneware bases. All these transformers are tested to twice their primary voltage before being passed, and accurate measurements of the drop in loss on open circuits are taken.

In the design of these transformers, more particular attention has been given to the construction of a transformer that shall have high efficiency at all loads, and small drop in volts. The table below of efficiencies at a periodicity of 100, with some of these transformers, illustrates this:

Output of transformer in kilowatts.	30	15	10	8	3
Full-load efficiency, per cent....	97·8	97·3	96·8	96·4	95
Half-load ,, ,, ...	97 3	96 6	96	95 5	93·8
Quarter-load ,, ,, ..	95·3	94·4	93·3	92·7	89 8
Eighth-load ,, ,, ...	91·3	89·8	88	86·8	82
Open-circuit loss ,, ...	1·17	1·4	1·7	1·88	2·67

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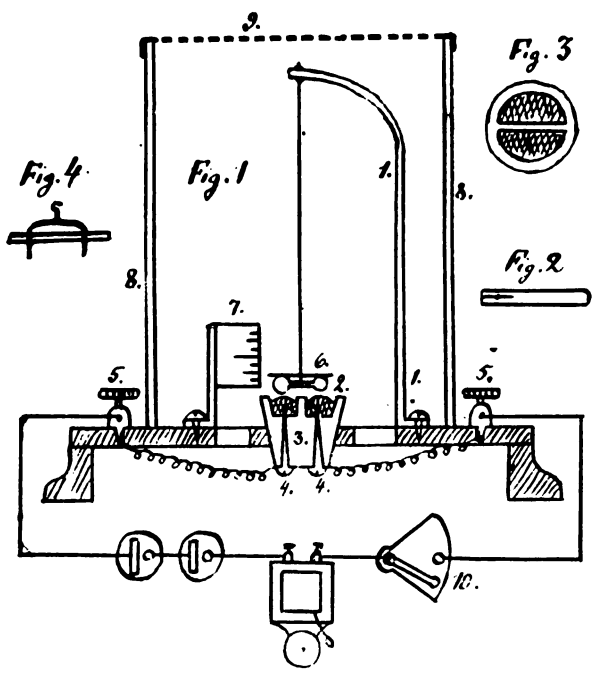
We are indebted to Mr. G. Glanville for the photograph of Sir David Salomons, and to Mr. P. Lancaster for that of Mr. H. L. P. Boot, which we have used to illustrate this description.

NOVEL APPLICATIONS OF ELECTRICITY.

BY R. W. HILL.

Herewith are the particulars of a simple, but efficacious, hygroscope with an electric attachment: Get a long hair from your lady friend, boil the hair for a while in a solution of soda, and one end of same attach to the brass or copper strip, 1 (Fig. 1), as shown in the horizontal section in Fig. 2. To the other end attach a tiny dumb-bell-shaped brass or copper, 2, electroplated with platinum. A small caoutchouc stopper, 3, is provided with two hollow apartments, as indicated in horizontal section in Fig. 3; put a few globules of mercury into them, and the two nails, 4, are connected by a wire to the two terminals, 5. To the brass, 2, is pasted a short piece of mica or straw, 6, and a small graduated paper scale, 7, is fixed near the suspended brass, as shown on the rough sketch. Cover the device with a glass cylinder, 8, provided with a cap made of wire gauze, 9, and the hygrometer is now ready. When the air is moist, the hair shrinks, and the brass will be lifted;



but when the air is dry, the little brass pendulum falls, closes the circuit of the bell, which will ring in a certain apartment in your house. In order to break the circuit, one-way switch, 10, is used. The stopper, 3, may be made movable, so as to adjust the alarm to any desired degree of humidity or dryness. The brass, 2, may be substituted by a short thick platinum wire with straw attached, as shown in Fig. 4.

Every chemist has experienced the difficulty of removing the glass stopper of a bottle when it has become fixed—apparently immovable. Of course, one of the best remedies is to heat the neck of the bottle for a while over a Bunsen burner. A serious drawback, however, of this old-fashioned method lies in the fact that the bottle must be held in a horizontal position, and the fluid or solution may be easily spilled out of the bottle if the operation is performed carelessly. I have solved this little problem in an up-to-date, efficacious manner by rigging up an adjustable clamp with coils of platinum wires embedded in a strip of asbestos attached to the said clamp. You press the circular clamp round the neck of the glass bottle, then "press the button, and electricity does the rest."

The last novelty is an electric annihilator of moths, flies, and the like-winged nuisance. It is an extremely simple though efficacious arrangement, consisting of an incandescent electric lamp placed inside a large glass globe, which is coated externally with a mixture of honey and wine or any other suitable sticky mass. Close the windows of the room, pull down blinds, close the doors, and make the room as dark as possible. Turn on the current, and a couple of hours later you will be surprised to see a lot of insects sticking to the said glass globe. The victims may be then "removed" with hot water, and the device is set afresh.

THE NEW BRITISH ELECTRIC INSTALLATION CONTRACTORS, LIMITED.

The official receiver's observations upon the failure of this Worcester company are of considerable length. The winding-up order was made on August 21 last, on the petition of a creditor presented on July 30, in respect of a debt for goods sold and delivered to the company, payment of which he had failed to enforce, although he had levied an execution, the whole of the company's property being claimed on behalf of the debenture-holders. The official receiver says:

The company was registered on October 29, 1892. Both the secretary (Mr. W. J. Hill) and the manager (Mr. J. H. Martin), who have attended upon me for preliminary examination, give the names of the promoters as Mr. J. Millington and Mr. J. Duce. The authorised nominal capital of the company was £25,000, divided into 5,000 shares of £5 each. Five of the signatories to the memorandum and articles of association appear to have treated the part which they took in the formation of the company as a formal and irresponsible matter (and it appears that they did not pay for any share or shares). The official receiver gives extracts from the original prospectus, which stated that the company was formed "for the purpose of acquiring and developing the business carried on by the British Electric Installation Contractors, Limited, at Worcester. The purchase-money of the business is fixed at £5,000, inclusive of all plant, stock-in-trade, etc., and payment is to be made partly in cash and partly in shares, as provided by the under-mentioned agreement. The company takes over the business as from November 1, 1892. The vendors pay the whole of the expenses attending the formation of the company."

It is alleged that such amounts as were subscribed in response to this prospectus were returned voluntarily. A supplementary prospectus, headed "private and confidential," was subsequently circulated amongst a limited number of local capitalists, without result.

The secretary of the present company was the liquidator of the old one. He was then, and still is, the chief clerk to Messrs. Griffiths and Millington. It was announced in the prospectus that the auditor of the company was Mr. Hubert Leicester, of Worcester, chartered accountant, but that gentleman informs me that he was not aware that he had been appointed auditor, and that he never conducted any audit of the company's affairs. The present solicitor, Mr. A. J. Beauchamp, has notified me that his appointment as solicitor of the company was not made till July, 1894.

The directors of the company have been Mr. J. Millington (chairman), Mr. J. H. Martin, and Mr. R. J. Surman. The last-named gentleman writes: "As I did not feel at all satisfied with the method of working, I sent Mr. Hill, the secretary, my resignation, dated February 10." The vacancy thus created was apparently not filled.

Mr. J. H. Martin, who was specially named in the winding-up order as the officer of the company required to wait upon me in reference to the affairs of the company, denies that he had anything to do with its promotion. He alleges that he was induced to join it by the offer of a joint managership, at a salary of £2 per week, which salary he admits receiving from February, 1893, to July last. He is now the holder of 46 ordinary shares and 500 debentures, in respect of which he asserts that he has paid the full value thereof. He also states that he was not cognisant of the true position of the responsibilities of the new company at the time he agreed to take up the 46 shares. Since the statement of affairs was lodged I have received a letter from him as follows:

"In lodging the sheets this morning with statement of accounts, there is on sheet F a note that the £500 that I lent to the company should rank *pari passu* with the other debentures. This I most strongly object to, as the first debentures are made up of bonuses and shares allotted free to the promoters, whereas mine is actual money lent to the company with the understanding that I was to be repaid out of the first moneys received, and when I asked for security these debentures were offered as the only security I could have for the loan, so I most certainly think mine should be a prior claim."

At the first meeting of the directors of the new company, held on February 11, 1893, it was resolved:

"That the following arrangement for the purchase of the business of the British Electric Installation Contractors, Limited,

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be confirmed, that the chairman be authorised to carry out the details thereof, and that the seal of the company be affixed to an agreement containing such provisions.

"That the purchase-money for the business of the British Electric Installation Contractors, including all plant, machinery, stock-in-trade, standards, poles, instruments, wires, fittings, wayleaves, rights-of-way, book debts, contracts and agreements, be the sum of three thousand pounds (£3,000), this company also taking over the existing liabilities of the vending company, it being understood that the value of the business is £3,200, and the balance of liabilities over book debts £200."

A formal agreement between the two companies for the payment of £3,000 6 per cent. first mortgage debentures, with a covenant to pay the liabilities of the old company, which, I understand, exceeded £500, was executed by John Millington as director of the old company, and James Duce as secretary, and by James Hugh Martin as director of the new company, and W. J. Hill as secretary. In his preliminary examination the secretary, who, as I have already pointed out, was also liquidator of the old company, stated that he did not fix the amount of the purchase-money; that there was no independent valuation; but that he believes the amount was arranged "by Mr. Millington and Mr. Duce, who were interested in both companies."

At extraordinary general meetings of the company, held March 11 and April 8, 1893, at which only four persons were present—viz., Mr. Millington, Mr. Martin, Mr. Duce, and the secretary—authority was given for the issue of £3,500 6 per cent. first mortgage debentures, as part of the authorised capital of £25,000; and at a subsequent meeting of the directors, held in July, 1893, the secretary was "instructed to issue debentures to the liquidator of the vendor company, as the purchase-money of the old business, for distribution among the vendors, such debentures to be filled up in such names as he may require." The debentures were, so the secretary informs me, "divided amongst the old shareholders upon the basis of their claims and interests in the old company, with a bonus."

The debentures were allocated thus:

Messrs. Griffiths and Millington	£1,400
Mrs. H. Duce	400
Ditto	650
Mr. Millington and Mr. Terry, trustees of Mrs. A. M. Duce	425
Mr. R. J. Surman	125
	£3,000

From further particulars supplied by Mr. Hill, I find that the debentures were appropriated in discharge of the following items:

Capital subscribed in cash by shareholders in the old company	£810
Promoters' shares allotted in respect of services rendered in the way of promoting the company	500
Cash advances to company	1,200
	2,510
Bonus added	490
	£3,000

Upon my enquiring of Mr. Surman the circumstances under which he obtained debentures in the new company of the value of £125 in lieu of the £100 shares which he held in the old company, he replies: "The £125 debentures were handed to me by the secretary, but I do not recollect why the company made the amount £125 instead of £100, unless it were in lieu of broken promises."

On January 27, 1894, the directors resolved "that the unallotted debentures, amounting to £500, be issued to Mr. Martin as security for his advances."

The debentures were of a wide character, embracing "the freehold and leasehold premises, plant, stock, licenses, book and other debts, property, goodwill, assets, and undertaking of the company, both present and future, including uncalled capital for the time being of the company as a floating security for the payment of the principle and interest for the time being due on this debenture."

The ordinary share capital of the company was represented thus:

Shares allotted to the seven signatories, one each of £5	£35
Mr. J. H. Martin, 46 ditto	230
Mr. J. Millington, 47 ditto (held on behalf of Mrs. A. M. Duce)	235

The following shares were subsequently paid for:

June, 1894, Mr. David Harper, 20	100
July, 1894, Miss R. Wheatley, 40	200

making the gross total of the share capital £800.

At a directors' meeting held on May 26, 1894, Mr. Millington reported "that he had been in negotiation with several gentlemen with a view to increasing the capital of the company, and that Mr. Harper had promised to invest £100." It is also recorded at the same meeting as follows: "Mr. Martin expressed his willingness to invest a further £100; Mr. Surman £50; Mr. Millington £100, provided £500 was invested altogether." Neither of the directors appears to have taken up these shares.

At a directors' meeting on July 18, 1894, the chairman reported that he had seen Mr. H. Turner, who had agreed to take £400 worth of shares in the company, and that he had communicated with Miss Wheatley, who had agreed to take up £200 worth of shares. A resolution was passed "that letters of allotment be sent to those two persons, and that the share certificates be issued and sealed with the seal of the company." Mr. Turner's shares were apparently not taken up.

It will be noted that, with the exception of Mrs. A. M. Duce, the ordinary shareholders in the new company do not apparently include as *bonâ fide* subscribers any of the persons who obtained the debentures in respect of their claims upon the old company.

The old company was registered in October, 1891. It was wound up voluntarily, and I have therefore no precise information as to its affairs. But the particulars set forth below may not be uninteresting as illustrating its financial position. The following paragraph is extracted from the petition:

"The old company was insolvent, and its shares valueless. The new company has been formed for the purpose of converting the shareholders in the old company who were debtors to the old company (inasmuch as they were the holders of shares in the old company credited as fully paid in respect of which no cash had been paid and no contract had been filed with the registrar of joint-stock companies) into secured creditors of the company."

Amongst the papers which have been handed to me by company's officers, I have found what appears to be a copy of a balance-sheet relating to the affairs of the old company. [This represents the position of the company from the time of its incorporation: no dividends, debenture interest, or other profits having been paid.]

The books of accounts which have been produced to me appear to have been kept in a very loose and imperfect manner. Many of the company's transactions have been passed through a private banking account of Mr. J. H. Martin. The secretary states that he has not had anything to do with the books of account, and that they have latterly been under the supervision of Mr. J. H. Martin. The question of book-keeping was discussed at a directors' meeting held May 26, 1894, when it was resolved that "provided the additional capital required is raised, the books should be kept at 50, Foregate-street, and that 25s. per week should be paid to Messrs. Griffiths and Millington for so doing." This arrangement does not appear to have been carried out.

What has been produced to me as the company's general cash-book appears, as to very many of its entries, to have been compiled at one and the same time. The receipt side of the book is only cast in pencil; the payment side is not cast at all, and the last payment recorded therein is made under date September 26, 1893. Against some of the receipts there is a remark in the cash-book, "Pd. Bank," but I cannot trace that these moneys were paid into the company's account; other receipts appear to have been handed to Messrs. Griffiths and Millington to repay them cash advanced for the benefit of the company, but I do not find such transactions properly recorded in the books produced to me. The pages of the cash-book are not numbered, and some of the entries are inaccurate. In some cases moneys were collected from the company's customers, and receipts given, but the company's official receipt forms were not used. Many of the company's transactions do not appear in the ledger. Entries appearing as credits in the ledger do not correspond with the cash-book, and cash credited as being subscribed by the shareholders cannot be properly traced either in the general cash-book or bank pass-book. In fact, the company's affairs, so far as they are exhibited by its books of accounts, are in a state of chaos. A letter has been received by me from Mr. Martin, in which he states:

"I made the stipulation when I joined the company that I was to have nothing whatever to do with the book-keeping, as I did not understand it. Further, a minute was made at a directors' meeting in the early part of 1894, that the books were to be kept at Messrs. Griffiths and Millington's, but after they had been there some months I enquired and found the books had not been kept. I had them back to our office and made an effort to put them in order."

The secretary attributes the failure "in the main to insufficiency of capital," but he adds, "I have not personally had the active management." My own opinion as to the precise causes of the failure I, for the present, withhold; but I may point out that as the old company had an authorised capital of £20,000, of which not one-twentieth part had been subscribed in cash, further information appears to be necessary as to why the new company was ever brought into existence.

The statement of affairs has been submitted by Mr. Hill and Mr. Martin. The unsecured liabilities are principally owing for goods supplied to the company. Two or three of the principal creditors, with whom I have communicated, inform me that they were not, at the time of supplying the company with goods, aware that such goods were subject to the debentures

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immediately they reached the company's premises. All the property of the company is claimed by a receiver, who was appointed on behalf of the debenture-holders on July 19 last.

The deficiency of £4,722. 16s., plus £1,977. 12s. 2d. (added in respect of the company's gross profits since its formation), and making a total of £6,700. 8s. 2d., is explained by the secretary and manager thus :

I. Expenses of carrying on business from date of formation of company to date of winding-up order—viz. :

	£	s.	d.
Salaries and wages	2,506	10	11
Rent, rates, and taxes	115	0	0
Miscellaneous trade expenses	355	14	11
Depreciation written off in company's books	—		
Interest on loans	54	0	0
	3,031	5	10

II. Depreciation on property not written off in company's books—viz.:

Electrical standards and other fittings erected in anticipation of development of lighting	150	0	0
Stock-in-trade	250	0	0

III. Other losses and expenses (if any) from date of formation of company to date of winding-up order—viz. :

Difference between amount of debentures issued to, and liabilities of old company, and tangible assets received in consideration	2,699	2	4
Expenses of formation (printing, postage, advertising, etc.)	320	0	0
Loss on Ledbury contract	100	0	0
Legal expenses, costs, etc.	100	0	0
Expenses of removing from 21, Broad-street to The Avenue, and additional expenses caused through obstruction of entrance	50	0	0
Total amount accounted for	£6,700	8	2

Mr. Luke J. Sharp adds : "This report has been prepared with the object of giving the creditors as much information as possible for the purposes of transacting the business at the first meeting ; but as the statement of affairs and books were not lodged with me till September 16, and such books are incomplete, I have not had time to make an exhaustive investigation of the company's affairs."

The summary of the statement of affairs shows, as regards creditors, that the company's gross liabilities are £4,363. 18s. 8d., of which £3,922. 16s. is expected to rank for dividend. The estimated assets are : stock-in-trade, £280. 5s. 9d. (estimated cost, £370. 12s.); trade fixtures, fittings, and utensils, etc., £9. 18s. 2d. ; good book debts, £150. 18s. 6d. ; a total of £441. 2s. 5d. ; deduct loans on debenture bonds secured on the assets of the company, £3,500 ; estimated deficiency of assets to meet the liabilities of the company, subject to the cost of liquidation, £3,922. 16s. The nominal amount of unpaid capital liable to be called up to meet this deficiency is nil. As regards contributories, the statement shows that there were 160 ordinary shares of £5 per share (11 shareholders) called up, adding another £800 to the liabilities, and making the total deficiency of the company £4,722. 16s.

PORTRUSH ELECTRIC TRAMWAY.

BOARD OF TRADE ENQUIRY.

Major Cardew, R.E., opened a Board of Trade enquiry on the 25th ult., in the Town Hall, Portrush, concerning the fatal accident which occurred on the electric tramway on August 2 last.

Mr. Wm. Moore, barrister-at-law (instructed by Mr. Thomas Taggart), represented ratepayers who are opposed to the present system upon which the cars are driven ; and Mr. H. W. Leech, Coleraine, appeared for the Electric Tramway Company. Lord Macnaghten, Viscount Templetown, Sir Francis E. Macnaghten, Bart., H.M.L., County Antrim, Prof. Fitzgerald, M.I.C.E., and Dr. Trail, F.T.C.D., were present.

The **Inspector** stated that he had been appointed by the Board of Trade to hold an enquiry into the fatal accident which occurred on the electric tramway on August 2 last. The Board of Trade had received complaints from various ratepayers, and he thought the best way would be for those complaints to be investigated first. After that they would hear what the company had to say in their defence.

Mr. Moore stated the case for the opposing ratepayers. At the outset he referred to the Acts of Parliament under which the tramway was worked. He pointed out that under the Act of 1880 the railway only extended from Bushmills to Portrush. In the year 1885 the company obtained another Act empowering them to construct a railway from Bushmills in the direction of the Causeway. The first railway was some six miles in length ; the additional railway was a little over two miles. In consequence of the lengthening he understood that increased water power was required, additional machinery was erected, and that larger engines were put up at the depôt at Bushmills. Now, what the ratepayers objected to was this—there was no security to the public, nor was there any advantage conferred upon the ordinary traffic by this electric tramway company. People who were accustomed to drive their cattle along the road—the highway—now made detours rather than expose their animals to the risk of contact with this electric rail What the Board of Trade would have to do would be to decide what were the proper precautions to be adopted if the tramway was to continue, having regard to the ordinary requirements of the public traffic. On behalf of his (Mr. Moore's) clients he intended to make proposals at the termination of the enquiry as to how the tramway should be worked, and he would suggest that the question of expenditure, whatever it might be, should not be considered where the public safety—life and property—was involved. If it be necessary, as he would ask them, to hold on scientific evidence that this third rail, which was now elevated some foot and a half above the surface of the road, should be removed, and another system—underground or overhead—adopted, the matter of expense, he submitted, was unimportant. This electric current had not only killed cattle, but had, unfortunately, deprived a human being of his life. If this tramway company were permitted to proceed in the manner they were now doing, no one could tell what the result might be. Counsel having alluded to the voltage at the generating station, directed attention to the fact that there was no automatic record kept, and read correspondence which had taken place between the company and ratepayers. If a man were driving a beast along the road he must be ever at its side, and the risk run was very great. In 1884 a Board of Trade enquiry was held into the working of the line, and it was decided that a notice cautioning persons of the danger would be sufficient. With great respect to the Board of Trade, he might ask what safety a poster offered to an ignorant bull or a person who could neither read or write? As representing a large number of ratepayers in the district who had lost cattle, he asked that some proper protection should be afforded, and that the present arrangement be prohibited.

Sir Francis Macnaghten was the first witness called.

Mr. Moore : Have you seen cattle injured on the line?—I have seen the dead bodies of cattle on the line and efforts made to resuscitate them. David Douglas lost a cow, and I saw a grey horse killed by the current up at the quarries.

The **Inspector** : Did you see any marks of burns upon them?—No, I did not examine them.

In answer to **Mr. Leech**, **Witness** denied having opposed the tramway from its inception, but he believed it had become a nuisance Shortly before 1884 he complained to the Board of Trade, and correspondence had taken place.

Somerset Fairley, cattle dealer, Coleraine, stated that a bullock of his was killed through coming in contact with the rail. After the accident he was afraid to fetch his cattle along the road.

Lyle Taggart, who has a farm between Bushmills and Portrush, said that in June, 1893, he was driving six cows and a bull along the road. Some of the cows had been shocked before, so they kept away from the rail, but the bull, which he had only a short time, touched the rail and fell. Witness rushed forward caught him by the tail, and pulled him off. Death ensued, however, in about five minutes.

By **Mr. Leech** : There was a ring in the bull's nose, but he had no rope attached. The bull was looking for grass, and happened to touch the rail with his nose. He immediately fell, struggled, and died. In pulling him off the rail they were shocked. At the present time witness admitted having grass sublet adjacent to the railway.

Hugh Macauley, labourer, remembered working at hay about four years ago contiguous to the Bushmills depôt, when he saw a cow with her right foreleg over the rail. Mr. Chambers, in the employment of the company, cut off the current, but the animal roared and died. Mr. Douglas owned the beast. Witness had seen the body of the cyclist, Thomas Walne, who was killed, and it was greatly discoloured.

Daniel M Mullan said he recollected the accident to John Hall's horse 10 years ago. It occurred on the Portrush side of Bushmills. A man named John Russell was driving. He wanted to get on the horse's back, and for that purpose drew the animal up close to the bank where the rail was. The horse touched the rail with his foreleg, and he fell. Witness ran to Russell's assistance, and they endeavoured to drag the horse away, but they had to let go because of the current. They then procured a rope, but the animal was dead when they got him off.

Dr. Traill remarked that although the company had paid compensation in several cases, they disclaimed entirely any liability.

Other evidence was given of the killing of cattle by contact with the conducting rail, and of complaints made to the Grand Jury by the cesspayers.

Samuel Cooper said that a servant girl named Jane Callaghan in his employment received a shock through simply touching a paling wire. It seemed that the current was communicated through an iron bar, which was resting against the electric rail. The girl could not let go, and witness experienced difficulty in dragging her away. She was unable to work for days owing to the soreness of her hands, which were burned.

At this stage the enquiry was adjourned until the following morning.

Upon the resumption of the enquiry, **Arthur E. Porte**, an electrical engineer of 20 years' experience, said that he had examined the generating station on the previous day. The pressure at the Bushmills station was 290 volts. There was one car on the line at that time. He would expect the voltage to be considerably higher if the number of cars were larger. There was not an automatic brake or governor on the cars, so far as he could see, nor was there an indicator to show the speed. There was not an efficient governor

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on the turbines at Bushmills. The speed indicator attached to the dynamo was not efficient, inasmuch as it was indicating wrongly when he saw it. The voltmeter could not be read at a distance of 18in.—he himself had not been able to read it at 6in. He did not see notice boards fixed in the electric generating station at Bushmills stating the maximum speed of the generator. He had made no leakage test, and could not say what waste might take place in the current along the line. There were a great many insulators broken and missing, and in wet weather there would be leakage. If there was a heavy load the resistance would of course, be greater, and would necessitate a higher pressure at the Bushmills end to maintain 250 volts at the Portrush end. He considered the line not safe as at present working up to 290 volts, having regard to the ordinary traffic of the road. There was possible danger to human life

Mr. Moore: You have considered the matter, and in your opinion how would you propose at the lowest possible cost, in fairness to the company, to put matters in a safe condition for the public?—I would cover in the rail so as to prevent contact with it, and still leave room for the connectors to travel on it.

Now, what sort would your covering be?—Preferably iron, but wood would do.

Only for the top and partly down the side?—Principally on the top. It might lap over a little on the side on which the traffic is.—And the shape of the tongue or slipper could be altered so as to catch the rails as at present?—Yes

Now, as to the turbines, would you propose any alteration in the present method of governing them?—I would like to see them governed automatically.

The **Inspector**: Would you link these governors with the electric circulators?—Yes, preferably. Continuing, witness said he would recommend a self-regulating voltmeter open to public inspection at the Bushmills junction, and more frequent inspection by officials

Mr. Porte was cross-examined by Prof. Fitzgerald with a view of showing that his proposed precautions were not absolutely necessary to the public.

The **Inspector**: If an electric conductor can be easily protected so that it will not be touched, there is no adequate reason for its remaining unprotected?

Mr. Porte: That is my point.

Further questioned, **Witness** said there would be considerable danger to a child by coming in contact with the rail.

By **Mr. Leech**: He had made no estimate of the probable cost to the company of the alterations he suggested. That was not within the scope of his investigation, but he should say, as compared with the cost of putting the rail overhead, it would be as the difference between hundreds and thousands.

The **Inspector**: In your opinion, if a person was drawn on to this rail, so as to press upon it with all his weight, would there be a greater chance of his sustaining injury than if he touched it of his own free will?—Yes, very much greater.

Mr. Moore closed his case by handing in the notes of evidence and verdict of the coroner's jury.

Mr. Leech, in replying, said the notice of enquiry which he had received certainly led him to the conclusion that the enquiry was to have reference to the unfortunate accident which led to the death of the young man Walne, but the proceedings had taken an entirely different course, for they had been dwelling upon the lamentable and deplorable deaths of heifers, cows, and horses. He always expected Mr. Moore to come to the point of the enquiry, but he showed them he was not going to grapple with a matter of such difficulty and doubt when he had plenty to satisfy his clients by assailing the Messrs. Traill about these dead animals. In the 12 years from 1883 to 1895 there had been nine animals killed. There was not the slightest doubt that there was an influential body of ratepayers personally opposed to the Messrs. Traill, or the tramway company, if they liked to put it so. But subscriptions were easily raised. After all, they had only proved the deaths of nine animals in 12 years, and some of the evidence, indeed, was second-hand. To bring it to vulgar fractions, it meant three fourths of an animal per annum. This was not such a matter as would induce the Board of Trade to interfere with the working of the line, or to place restrictions upon it which were not necessary to the safety of the public. The killing of the cattle did not strictly come within the scope of the enquiry, but he had not objected because it led up to the case which ought at least to have been attempted. The line had been laid for the public advantage, and there was also the benefit of a footpath from Bushmills to Portrush, without any cost to the county. It was illegal, of course, for a person riding a bicycle to use that footpath, but as such it was used along its entire length. Having argued that Walne had no right to attempt to get on the footpath with his bicycle, that it was probable that the great force with which he was thrown off the bicycle against the electric rail might have caused death, and that the Board of Trade regulations had all been complied with by the company, Mr. Leech concluded by stating that a weaker case had never been presented—in fact, there was nothing to meet but the overwhelming eloquence of eminent counsel brought down from Dublin.

David Christie said he had lived in Portrush for the past 33 years. He had not the slightest interest in the railway. He had been in the habit of taking shocks by catching the elevated rail with his hands.

The **Inspector**: What did you take them for?—For mere curiosity. He had taken them in all sorts of weather, and had felt no ill-effect. When the rail was wet he had caught it without any injury being done. On one occasion he sat down on the rail to rest himself, with his feet upon the ground rail. He received a slight shock, but it did him no harm. He had once struck the electric rail with a piece of iron and produced sparks. Tourists were wont to do the same thing out of curiosity.

James Lecky, manager Portrush gasworks, said he, too, had taken shocks for curiosity. He had known rheumatic people come specially to Portrush to get at the electricity, as it had the name of doing them good. Witness had caught the rail when wet, and taken shocks very near the generating station.

John M'Kay stated that he had frequently taken shocks when the rail was both wet and dry, and found no ill-effects. He had seen other persons touch the rail.

James Boyd, inspector of the line, had also frequently taken shocks—of his own accord and otherwise—under different circumstances and in all kinds of weather. On one occasion, when the chain of a car got deranged on a journey, he had of necessity to lie on his back to get at the injury, and during all that time—15 minutes—his head was leaning against the rail through which the current was passing. He felt the shock, but he was not in any way injured. His head was not singed. A drunken man fell asleep across the rail, his neck touching it. Witness was driving the electric car at the time, and was within an ace of running over him, as it was at night and very dark.

By **Mr. Leech**: The current was on at the time; just at the same pressure as when the unfortunate cyclist lost his life. Witness had made various experiments. He had touched the rail with wet grass to test the effect. He received shock, but no injury. In 1885 a horse bolted on the road, and struck the rail with his forelegs. They had difficulty in getting the animal off, but he was not injured. A few hairs were taken off. The driver also touched the rail, but was not injured. Witness gave several instances where people and horses struck the conducting rail without receiving any harm. A horse and cart one time ran into the engine, and got so wedged in between the electric rail and the tram that great difficulty was experienced in extricating them, and a considerable time elapsed. Three of the driver's ribs were broken, but he was in no wise injured by electricity, although he was pressed against the rail. He had seen Mr. John Taggart make a horse touch the rail, and the animal received no injury. He had also seen a man mount a horse by stepping on the rail. It was a usual thing for children down at the Causeway to catch the rail for fun, and still no harm was done.

Prof. Fitzgerald was then called, and examined by **Mr. Leech**.

You are well versed in electrical science?—Yes.

In your opinion is there any danger to a person up to 250 or 300 volts?—No serious danger.

Is there danger to cattle?—I think there is.

The **Inspector**: Why do you think that there is danger to cattle and no danger to human beings?—Because of the many experiments that have been tried. Drunkenmen and others have touched and lain upon the elevated rail while the current was passing, and no injury had resulted. On the other hand, cattle and horses, according to the evidence, had been killed.

Prof. Fitzgerald: I think the jury were dissatisfied as to the cause of the death of the cyclist. If they had intended to say that the electric shock killed the man they would have said that death was due to the current It certainly was an extraordinary case.

Mr. Leech said he had several other persons ready to be examined, if thought fit, who had caught the rail and sat down on it without any ill-effects, but he did not consider their evidence necessary. It would be merely corroboration, and he did not wish to unnecessarily prolong the enquiry.

Mr. Moore then made a few remarks. He pointed out that the enquiry was not held simply into the fatal accident which unfortunately had occurred, but into the entire working and condition of the line. The death of the cyclist had only brought things to a head The Acts of Parliament referred to gave the company no authority to use the rail in its present position, but when constructed the Board of Trade approved of it, and he supposed the same Board would have power to order its removal. And now that it had been proved that the rail was a source of danger, he submitted that the Board of Trade were bound, in the interest of the public, to have the rail so safeguarded that those dangers would cease Although the company had never admitted liability, they went so far as to recognise that they were in the wrong by paying compensation in almost every case of accident. If the Board of Trade came to the conclusion that the electric rail was dangerous—and he asked them to decide that it was—the electricity could be stayed until proper safeguards were constructed. And the company need not suffer in the least, for they had steam-engines which would prevent any suspension. He might also suggest that there ought to be automatic governors on the turbines.

The **Inspector** said he would send in his report, and the Board of Trade would give their decision in due course.

COMPANIES' MEETINGS AND REPORTS.

FROGGATT'S ELECTRIC LIGHTING COMPANY, LIMITED.

The first annual general meeting of this Company was held on September 30 at Winchester House, E.C., the chairman of the Company, Mr. A. de Murrieta, presiding.

The report, which, with the statement of accounts, is made up to May 31, says:

"The general progress has been, on the whole, satisfactory, though hardly equal to what the directors expected. Several contracts have been secured, among the most important of which may

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be mentioned the London Tramways Company, Limited, the Glasgow Corporation Tramways, and the proprietors of the leading South London omnibus services. The Board have the pleasure to report that applications are continually being received for the lighting of omnibus and extensive tramway services in the Metropolis and other populous centres in the United Kingdom, as well as on the Continent, and together with the enquiries which are increasing day by day for agencies to retail the various specialities manufactured by the Company, justify the expectation that a large business will result, more especially considering the experience that the directors have now acquired. In order to successfully carry out the various contracts entered into, and for the purpose of manufacturing accumulators and other fittings for this branch of the business, almost the entire outlay of the called-up capital has been necessitated, and as two of the principal contracts are not yet completed, and the majority of the others have only been running a few months it is not surprising that the accounts show a balance (£1,236. 12s. 8d.) to the debit of profit and loss account. A further cause which has contributed to this result is the fact that a large number of advertising discs, consequent upon the incompletion of the two contracts referred to, have been unproductive; also that it has necessarily taken time to secure customers for those that have been available, but as their undoubted value is rapidly becoming known to advertisers, and as improved arrangements have been entered into with the Company's agents (Messrs. Willing and Co., Limited), the directors have every confidence that these drawbacks will very shortly be overcome In the capital account shares to the extent of £17,120 remain to be issued, but having hitherto had sufficient capital for their requirements the Board have considered it was more in the interest of the existing shareholders that further shares should only be issued when money was required. It is, however, proposed to ask for further subscriptions, but only in such quantities and at such intervals as may be deemed necessary. On December 13, 1894, the Honourable Chandos S. Stanhope joined the Board as a director of the Company, and in informing the shareholders that he has, owing to ill-health, been obliged to leave the country, and has since felt impelled, on account of his continued absence, to resign that position, the directors are certain that the regret they feel at these circumstances will be shared by all."

The **Chairman**, in moving the adoption of the report, said that it was a very great disappointment to the Board that it was not a more favourable one. In all new businesses the first year was always very difficult, and in their case they had found it full of difficulties, especially in regard to that branch of their business which related to the lighting of public vehicles. With the experience they had, however, they were confident of overcoming these difficulties. Under present contracts they were supplying 500 lights for the London tramways and 800 for the Glasgow tramways. They had also sold some apparatus for lighting omnibuses in the Isle of Man. The extension of this branch of their business required serious consideration, owing to the capital it absorbed, and also because of the rough treatment their batteries were subjected to, owing to the class of men they had to employ. However, an arrangement had now been come to with the London Tramways Company by which their own staff did the work, and the directors intended to propose a similar arrangement to the Glasgow Corporation. The Board had been disappointed with the returns from their advertising discs They had secured long contracts for advertisements, and they hoped to make further progress with the empty space still at their disposal. They were now devoting more attention to portable lights for houses, bicycles, travelling and policemen's lamps. There was another branch they had in hand, the details of which he thought best not to mention, except that a very influential firm had approached them with a view of securing the agency for it. The directors had given their services without remuneration, and though they had not been able to realise any profits they had devoted much more time and attention to the business of the Company than they had ever contemplated would be necessary. A considerable amount of friction and disagreement had arisen on the Board and between the Board and the manager, and they thought it was very advisable that the shareholders should appoint a committee to confer with the directors with a view to reorganising the Board.

Dr. Macgill, managing director of the London Tramways Company, seconded the adoption of the report.

Mr. Diamond said he should like to propose the name of a gentleman to serve on the committee.

Mr. H. Keeble, the Company's solicitor, said that could not be done that day.

The report was carried, and some further conversation took place as to when the meeting would take place for the election of the committee, both the Chairman and Mr. Hackforth Jones stating that it would be as soon as possible, though a precise date could not be fixed.

The retiring director, Mr. C. de Murrieta, and the auditors, Messrs. W. P. Eldred and Co., were then re-elected, and the meeting closed with the usual votes of thanks.

HAWAIIAN TRAMWAY COMPANY, LIMITED.

The eighth ordinary general meeting of the shareholders of this Company was held on September 30 at the Cannon-street Hotel, E.C., Mr. H. R. Armstrong presiding.

The **Chairman**, in moving the adoption of the report, which recommended a dividend at the rate of 1¼ per cent., leaving £41 to be carried forward, stated that the cause of the decline in the profits was the enforcement of martial law, which had been necessitated by the change from a monarchy to a republic. Owing to this the hours of movement were curtailed and the usual pursuits of the population were upset. The profits of the Company had thus been reduced by about 5,000dol., but if the traffic returns of the past few months were maintained they would do very well. An omnibus proprietor had for some time been running against them, and in order to protect their interests it had been necessary to start omnibuses of their own and "nurse down" the opposition, as it would have been very bad policy to buy it out. They obtained permission from the Legislature in 1890 to use electric traction, but up to the present they had been unable to recommend its adoption to the shareholders, owing to the expense both of the installation and conversion. In America electric traction was greatly used, and no doubt it had an advantage in many instances over horse traction. Some company promoter brought forward a Bill for electric traction in opposition to this Company's, but the measure was thrown out in Honolulu. There still, however, remained a desire for electric traction on their tramways, and the directors were taking every step to enquire the price of the conversion and the cost of generating and renewal. It was very difficult to obtain correct details as regarded renewal, electric tramway accounts not yet being perfectly clear on this head. They would wish to convert, run, and renew themselves, but they must be assured that the shareholders would receive benefit as well as the travelling public. When they had the whole information ready, they would report the fact to the shareholders and call a meeting of them before going any further in the matter.

Colonel C. E. Macdonald seconded the motion, which was adopted.

WILLANS AND ROBINSON, LIMITED.

Directors: Mark Robinson, M.I.C.E. (chairman), Sir Gilbert A Clayton-East, Bart, Captain H. Riall Sankey, R.E. (Ret.), M.I C.E.

The third half-yearly report of the directors, to be submitted at the ordinary general meeting of the Company, to be held at the City Terminus Hotel, Cannon-street, E C., at 3 p.m. on Tuesday, October 8, 1895, states: The accounts for the third half-year of the Company's operations, ending June 28, 1895, are submitted herewith. The engine orders in the half-year amounted to 12,832 i.h p., against 10,315 in the corresponding half of 1894, and 9,290 in that of 1893 (old company). As previously pointed out, the Company has great difficulty in keeping pace with its orders, and the fast increasing demand for the Willans engine, though encouraging for the future, is only a source of embarrassment in the present, and must continue to be so until the new works at Rugby are completed. Notwithstanding this serious drawback, the result of the half-year's work is satisfactory. After writing off as depreciation from plant, patents, etc., the large sum of £3,762. 0s. 3d. (exceeding by nearly £900 the liberal amount written off last half-year), the balance to the credit of profit and loss account for the half-year is £10,614 2s. 7d. Out of this the directors propose that dividends be paid at the full rate of 6 per cent. per annum upon the preference shares, and at 7 per cent. per annum (as before) upon the ordinary shares, together amounting to £6 586 5s. 2d. The amount payable to the directors, in accordance with the articles of association, is £1 208 7s. 3d., and it is proposed to carry £2,500 to the reserve fund, raising the latter to £5,146. 9s. 11d. The balance, £319. 10s 2d., it is proposed to carry forward. Arrangements for the manufacture of the Willans engine upon the Continent, under license, have made further progress. "Royalties receivable" appear for the first time in the accounts, and this source of revenue is likely to increase. Licenses for certain countries have been granted upon satisfactory royalty rates, and in connection with these licenses certain sums down have also been received. After writing off all expenditure incurred in arranging the licenses, the sum of £3,632 12s 1d. remains to the credit of profit and loss, enabling the directors, as already stated, to write off about £900 as increased depreciation, and to reserve an equal amount in the valuing of other accounts. They are also able to carry an unusually large sum to the reserve fund. The balance of the shares authorised to be issued (to which the attention of shareholders was called by circular, dated June 1 last) has been taken up The applications for shares considerably exceeded the number to be allotted. The entire debenture debt, amounting to £9,910, was paid off as from March 31 last. Many of the debenture-holders applied for and were allotted shares in lieu of the cancelled debentures It was thought desirable to perpetuate as nearly as might be the system of workmen's debentures, which has been for some years in force, and workmen's bonds, to the amount of £1,080, were issued to the holders of cancelled workmen's debentures, bearing the same interest as the latter. The increase under salaries is chiefly due to a change in the mode of paying certain officers of the Company, by which they appear in the salary list instead of in the wages list. The change has no effect upon the final result. The new works at Rugby make satisfactory progress, though they cannot commence to add much, if anything, to the out-turn from the Company's workshops for another six months. Up to the present time contracts for buildings, etc., have been placed to the amount of about £18,700.

Reuter's Telegram Company, Limited.—The directors have declared an interim dividend at the rate of 5 per cent. per annum, tax free, for the half-year ended June 30.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Tongres.—The Municipal Authorities of Tongres (Belgium) invite tenders by October 12, 1895, for the concession for the installation and working of the electric light in the town.

Brussels.—Tenders are invited by October 16 for the supply of telegraph cables and copper wire in two lots, for the Administration of Telegraphs. Particulars at the Administration des Chemins de fer, des Postes, et des Télégraphes, Brussels.

Paris.—Tenders are invited for the supply of electric cables, in two lots, for the Administration des Postes et des Télégraphes. Particulars are obtainable of the Administration, 103, Rue de Grenelle, Paris, where tenders are to be sent by October 10.

Madrid.—The Director of Public Works invites tenders by November 15 for the concessions of the construction and working of a tramway from Madrid to Colmevar Viejo, with branches to Chamartin and Rosa. Security, 12,505 pesetas. Particulars at the Direccion General de Obras Publicas (Ministerio de Fomento), Madrid.

Bedford.—The Electric Lighting Committee invite tenders for the supply and delivery of 200 cast-iron lamp columns, carriers, and globes, in accordance with plans and specifications, a copy of which can be obtained at the office of Mr. T. S. Porter, clerk, Town Hall, Bedford, on payment of a fee of 5s. Tenders, marked "Electricity," must be delivered to the clerk by October 8.

London, E.C.—The Bengal and North-Western Railway Company, Limited, are prepared to receive tenders by October 16 for the supply of 22 copper tube plates. Specifications, with form of tender and general conditions of contract, may be obtained at the company's offices, 237, Gresham House, Old Broad-street, E.C., upon payment of 10s. each. Tenders must be addressed to Mr. E. L. Marryat, secretary.

Edinburgh.—The Lord Provost, Magistrates, and Council invite tenders for the wiring of the Waverley Market. Specifications and forms of tender can be obtained at the resident electrical engineer's office, 5, Dewar-place, Edinburgh. A deposit of £1 is required, which will be returned on receipt of bona fide tender. Tenders are to be sent to Mr. Thomas Hunter, W.S., town clerk, City Chambers, Edinburgh, endorsed "Tender for Wiring Waverley Market," before 10 a.m. on 12th inst.

Newport.—The Corporation of Newport are prepared to receive tenders by October 11 for wiring and for supplying and fixing electrical fittings at the provision market and public baths, Newport. Copies of plans and specification may be obtained upon application to Mr. R. H. Haynes, borough engineer, Newport, upon payment of £2. 2s. Tenders, endorsed "Market and Baths Wiring," to Mr. Albert A. Newman, town clerk, Town Hall, Newport.

Chepping Wycombe (Bucks.).—The Urban Sanitary Authority for this borough are prepared to receive tenders from public companies for working the electric order obtained by them within the borough for a term of years and upon approved conditions. Tenders are to be delivered by noon on October 14 next, at the office of the town clerk, High Wycombe, where a copy of the electric order may be seen and further particulars obtained. The Authority do not bind themselves to accept any tender.

Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

Croydon.—The Council are prepared to receive tenders for wiring and for supplying and fixing electrical fittings at the New Town Hall, Courts, and Free Library. Copies of the specification may be obtained upon application to the architect, Mr. Charles Henman, A.R.I.B.A., 64, Cannon street, London, accompanied by a deposit of £2. 2s., which will be returned on receipt of a bona fide tender. Plans of the lighting system may be seen at the architect's office, as above, and at the New Town Hall, Croydon. Tenders to be sent to Mr. C. M. Elborough, town clerk, by October 8.

Blackburn.—The Corporation of Blackburn invite tenders for the following: Contract No. 1.—High-tension concentric cables, low-tension triple concentric cables, cast-iron pipes, junction-boxes, drawing in boxes, service-boxes, etc. Specification, conditions of contract, and forms of tender may be obtained at the offices of Mr. E. M. Lacey, 10, Delahay-street, Westminster, on and after September 23, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders, sealed and endorsed "Electricity Extensions," must be delivered at the Town Hall, Blackburn, on or before October 5.

London, W.—The Great Western Railway Company desire tenders, among other stores, for the supply of telegraph instruments, telegraph apparatus, copper wire, G.P. wire, etc., telegraph ironwork and tools, telegraph drysalteries, carbons for electric light, iron wire, acids, alkalies, zinc, telegraph poles, from November 1, 1895, to October 31, 1896. Samples and patterns may be seen on and after 23rd inst. at the office of the stores superintendent, Paddington Station. Specifications, with forms of tender, may be obtained at the office of the stores superintendent at Swindon or Paddington Stations. Tenders, addressed to Mr. G. K. Mills, secretary, Paddington Station, London, and marked outside "Tender for Stores," will be received on or before October 7.

Dundalk.—The Dundalk Town Commissioners invite tenders for erection of an electric lighting installation for the purpose of lighting the town by electricity on or about July 1, 1896, reserving to themselves the right of taking over the plant at the end of a term of years—this term to be stated in the tenders. The successful contractor to have the right of supplying private consumers, while the Commissioners will pay a fixed sum yearly for the town lighting—this sum to be stated in the tender also. The Commissioners have obtained a license from the Board of Trade for supplying electric lighting. Tenders will be received by Mr. Edward Farrar, town clerk, Town Hall, Dundalk, up to October 7.

RESULTS OF TENDERS.

Kingston-on-Thames.—The following tender has been accepted for the supply of coal for the electric lighting works, for the Town Council: T. Styles, Durham rough, small, 11s. 6d., Hartley rough, small, 9s. 9d., and Welsh nuts, screened, 16s. 9d. per ton.

Lincoln.—The following were the tenders for the new chemical laboratory at the School of Science and Art. Mr. W. Watkins, F.R.I.B.A., Lincoln, architect:

M. Otter and Co.	£231
W. Wright and Son	225
A. B. Wright (accepted)	207

BUSINESS NOTES.

Belfast.—It is proposed to light the Belfast Lunatic Asylum by electricity.

Rand Central Electric Works, Limited.—The directors have made a call of 5s. per share.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3 249.

Aberdeen.—The electrical installations at the new police station have been carried out by Messrs. Shirras, Laing, and Co.

Stafford.—The formal opening of the electric lighting works is to take place on the 15th inst., but the current will be switched on for a few days previously for testing purposes.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—The directors have declared an interim dividend for the quarter ended June 30 of 2s 6d. per share, tax free.

Wimbledon.—The Ratepayers' Association have decided to convene a public meeting on October 8 to take into consideration the scheme of electric lighting adopted by the District Council.

The Safety Tread Syndicate, Limited (Mason's Patent), have been appointed contractors to H.M. War Office, the Admiralty, and the India Office for the supply of their well-known safety treads.

East Grinstead (Sussex).—The Urban District Council, who are somewhat dissatisfied with their gas supply, have appointed a committee to meet Messrs. Owen and Pike on the subject of the electric light.

Globe Telegraph and Trust Company, Limited.—The directors have declared an interim dividend of 3s. on the preference shares, less income tax, and of 1s. 3d. on the ordinary shares, income tax already deducted.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 29th ult. amounted to £1,266, as compared with £988 in the corresponding week of last year, being an increase of £278.

Direct United States Cable Company, Limited.—The Board have resolved upon the payment of an interim dividend of 2s. per share, free of income tax, being at the rate of 2 per cent. per annum for the quarter ended September 30.

Isle of Man Tramways and Electric Power Company, Limited. The directors have declared an interim dividend for the six months ending June 30 at the rate of 6 per cent. per annum on the preference shares, and at the rate of 7½ per cent. on the ordinary shares.

Drake and Gorham.—This firm have just had placed with them the contract for the electric lighting by means of a separate plant of The Lea, Esher, for Mr. C. C. Wyllie. In London they are proceeding with the wiring of Major the Hon. E. R. Bourke's house at Great Cumberland-place.

Bearpark (Durham).—The Parish Council have considered the question of lighting the parish, when it was resolved that the question of lighting stand over until the Council meet a representative of the owners of Bearpark Colliery, with a view of ascertaining the probable cost of the electric light.

Londonderry.—Alderman Fleming said, at the meeting of the Lighting Committee of the Corporation, that he quite agreed with Alderman Pollock that the electric light was needed in the churches, as the gas lighting was very bad. He hoped the chairman would soon call a meeting to consider this matter.

City and South London Railway.—The returns for the week ended September 29 were £823, compared with £881 for the corresponding period of 1894, being a decrease of £58. The total receipts for the half-year 1895 are £10,971, compared with £11,119 for the corresponding period of 1894, being a decrease of £148.

Peterborough.—The borough engineer has reported to the Town Council on the scheme for electric lighting proposed by him in consultation with Dr. Fleming, and recommended that applica-

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tion be made to the Local Government Board for sanction to borrow £20,000 for the proposed works. The report was referred back for the engineer to reconsider and revise

Universal Electric Carriage Syndicate, Limited.—This Company has been registered with a capital of £5,000 in £1 shares. Object: to enter into an agreement with W. C. Bersey, and to carry on the business of electricians, electrical engineers, etc., in all its branches. The directors are D. B. Miller, R. J. Hinton, C. N. Stewart, and (after allotment) W. C. Bersey (managing director).

Agency.—Mr. D. J. Russell Duncan, formerly senior partner in the firm of Messrs. Duncan Bros., engineers, Westminster, and late managing director of the Steel Pipe Company, Limited, has commenced business at 80, Boulevard Haussmann, Paris, as agent for the sale of machinery, electrical apparatus, and specialities of British manufacture suitable for French trade, also for the sale of inventions protected in France.

Bermondsey.—The Vestry have received notification from the Capital and Counties Electricity Supply Company, Limited, of their intention to apply, on or before December 21 next, by memorial to the Board of Trade, for a provisional order, authorising the company to supply electricity for public and private purposes within the area of the jurisdiction of the Vestry. The matter was referred to committee.

Lithanode Electric Storage Company, Limited.—This Company was registered on September 23, with a capital of £12,000, in £1 shares. Objects: to acquire the business carried on by the Lithanode and General Electric Lighting Company, Limited, Millbank-street, Westminster, to enter into agreements with the said Company and its liquidator, and to carry on business as electricians and electrical engineers in all its branches.

Jean Concessions Guiana Rubber Company, Limited.—This Company has been registered with a capital of £100,000 in £1 shares. Object: to adopt and carry into effect an agreement, made September 4, between Joseph M. Jean of the one part and Jn. A. Russell, on behalf of this Company, of the other part, and to carry on business as rubber-tree growers and merchants, timber growers, farmers, indiarubber manufacturers and merchants, etc.

Marine Cable for Japan.—The Japanese Government have ordered 800 miles of submarine cable from the Telegraph Construction and Maintenance Company, this, it is understood, being intended for effecting telegraphic communication between Japan and Formosa. It is stated that the Japanese have determined to lay this cable themselves, and that they are having a cable ship built in this country, so that they will soon be in a position to lay and repair their own cables.

Important Belgian Enterprise.—On September 25, as already advised, the Société générale belge d'entreprises électriques was constituted at Brussels with a capital of 6,000,000f., which may be increased to 10,000,000f. Interested in the undertaking are the Société générale des chemins de fer économiques, Compagnie générale des chemins de fer secondaires, Banque de Bruxelles, Banque de Paris et des Pays-Bas—all of Brussels; further, the Comptoir National d'Escompte de Paris and the Gesellschaft für elektrische Unternehmungen (Union), of Berlin.

Chelmsford.—The Chelmsford Electric Lighting Company have written to the Town Council regretting that on two nights recently there was a failure in the street incandescent electric lighting supply. In order to meet the wishes of the Council and abate a smoke nuisance which had been complained of, the company had been engaged in fitting their boilers with patent smokeless furnaces, but in doing this they had found that their reserve boiler power was insufficient to keep the lights going. There was now every reason to believe that no further inconvenience would accrue.

Blackpool.—The other day two transformer-lids were blown off. It is supposed that sparks ignited the gas which had collected in the chambers. Councillor Pearson, at the last meeting of the Town Council said that it was pleasing to note that the electrical works were going on from success to success, and financially they were reaping large results week by week. With respect to the tramway, he reported that the Board of Trade had granted the license to work the Lytham-road section. The committee put it into force forthwith, and the electrical cars were working to South Shore station.

Appointment Vacant.—The Dundalk Town Commissioners will at their meeting on October 29 appoint an electrical engineer for reporting on the cost and the best means for lighting the town by electricity, and also to assist the solicitor in obtaining a provisional order from the Board of Trade granting power to the Board to erect works and plant to supply electricity within the borough Applicants will be required to state a bulk sum, if possible, which will cover all fees and expenses incidental to the work they propose to undertake. Applications to be sent in to Mr. Edward Ferrar, town clerk, Town Hall, Dundalk.

The Imperial Western Australian Corporation, Limited, with a capital of £500,000 in £1 shares, of which 5,000 are deferred shares, has been formed for the purpose of conducting the business usually carried on by an exploration and finance corporation; to prospect, acquire, develop, and otherwise deal with mining and other properties in the colony of Western Australia and elsewhere; to promote sub-companies; to purchase, lease, or work such properties; to purchase, resell, sub-divide, lease, or otherwise deal with lands (including town sites); to obtain concessions for and construct railways, tramways, electric lighting, harbour, and other works in the colony of Western Australia, etc.

Swansea.—The negotiations which have been carried on by the Swansea Corporation and the proprietors of the tramways for the purchase of the latter have not yet reached a definite point. Two years' time is still left for the municipal authorities to make up their minds what to do. The tramway company, in the event of another lease of 31 years being granted, will, we understand, undertake to relay the lines throughout and give an improved service by means of electrical power. It is stated that the directors have already determined upon using electrical power instead of horses, and that as soon as a definite arrangement is made with the Corporation the necessary electrical plant will be secured.

Liverpool.—On the motion of Alderman F. Smith, seconded by Mr. Brownbill, the following recommendation of the Special Lighting Committee of the Corporation has been agreed to: "That, in accordance with the agreement, dated May 28, 1895, between the Liverpool Electric Supply Company, Limited, of the one part, and the Corporation of the other part, a further agreement be made by the Corporation with the company to complete the purchase of the company's undertaking, works, and property in accordance with the before-mentioned agreement within six weeks from the date of an Act of Parliament authorising the sale to the Corporation, provided such Act is passed in the year 1896, and that the seal of the Corporation be affixed to such agreement."

Halifax.—The Tramways Committee's report to the Town Council contains details and plans and estimates for an overhead tramway system given by Messrs. Easton, Anderson, and Goolden, Limited, who are prepared to construct and lease the lines. Two routes are suggested—one from the railway station by Horton-street and Commercial-street to King Cross, and the other from the Grand Theatre to Haley-hill and Boothtown. The cost to the Corporation of the roadwork is estimated at £12,500 for the 3½ miles, and the firm's rough estimate for erecting and equipping an overhead electrical system service is about £18,500. At Wednesday's Council meeting it was decided that the matter be referred to the new November Council.

New Arc Lamp.—The arc lamp is now displacing to a great extent in lecture illustrations the oxy-hydrogen light, which was itself a great advance upon the old oil-lamp form. Improvements in the first-named were shown last week at the Camera Club. They have been patented by Mr. Cecil M. Hepworth, and the apparatus is known as the Ross-Hepworth arc lamp. The design is said to be simple and possess all the means necessary for keeping the light spot central with the lens. The light itself is steady, and the brilliance may be regulated according to requirement. The most novel feature is the device by which the arc can be struck instantaneously, and arrangements, we are informed, are being made to test its usefulness in this respect for naval searchlight purposes. The lamp is manufactured by Messrs. Ross and Co, opticians, Bond-street, W.

Telephones in Germany.—The telephone exchange at Essen, the town famous for Krupp's gun factory, was last week fitted up with multiple switchboards (for 6,000 subscribers) which have been manufactured and erected by Messrs. Mix and Genest, Limited, of Berlin, for the German General Post Office. We read in the local paper that the telephone service has thereby been greatly benefited, as the attention is more prompt, and less noise is noticeable at the exchange, the previously stereotype enquiries, "Have you finished?" not being needed with these patent multiple switchboards, as testing is done by galvanometers. The neighbouring towns of Dortmund, Bochum, etc, had previously been fitted with multiple switchboards of the same system and manufacture, where the working of the same had given great satisfaction, thereby accelerating the transformation of the old exchange at Essen into one equipped with the most modern apparatus.

Holophane Globes.—An exhibition was given in the showrooms of the Liverpool Gas Fittings Company the other day of a "new discovery in lighting which increases the amount of light obtainable by all systems of illumination, whether gas, oil, or electricity." It is stated that a company is about to be formed to purchase the patent rights of the invention for all countries except Great Britain and Ireland of Messrs. Blondel and Psaroudaki for the manufacture of Holophane globes, which it is asserted have been used with success in Paris for some months. Among the advantages claimed for the new globe are that it is grooved vertically inside in order to diffuse the light, and grooved horizontally outside in order to distribute the light; moreover, it gives such a perfect diffusion of light that the gain in the power of illumination is said to reach 13 per cent., whereas the loss of light by use of the ordinary shades ranges from 10 to more than 50 per cent. The globes were illustrated in our issue of April 19, p. 449.

Douglas.—The Finance Committee of the Douglas Town Commissioners have advanced a stage the projected cable tramway to Upper Douglas. The draft of the Bill was laid before the committee and considered, also the agreement between the tramway company and the Commissioners. Several enterprising tramway schemes are under consideration in the island, including the extension of the electric tramway to Ramsey, and the extension of the Snaefell railway to Tholt-e-Will by the back of Penny Point Mountain to Ingebrack, and thence to Douglas by Baldwin and Kirk Braddan. A company is in process of formation at Douglas for the purpose of constructing and working an electric tramway along Douglas Head Marine Drive. The Drive is nearly three miles long. In return for the concession of constructing and working a system of trams the new company agree to pay the Marine Drive Company one penny for each passenger conveyed. It is stated that the Douglas and Laxey Electric Tramway Company at the north of Douglas Bay have carried 30,000 passengers in one week. Major Goldie Taubman, Speaker of the House of Keys, is chairman of the new company.

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St. Pancras.—The Vestry discussed at their last meeting the question of lighting some of the streets of the parish by incandescent gas. Mr. Hodgson said that after a considerable period they were lighting four miles of streets in St. Pancras by electricity at a cost of £6,000. If they multiplied that sum by 21—the number of miles of streets in the parish—they would see what it would cost to light the whole of the borough. A proposal made that a letter respecting the lighting of the streets by incandescent gas should be simply acknowledged was eventually carried. The electricity works at the King's-road station are now practically completed, and as soon as the work of connecting is finished the supply will be turned on. Most of the destructor furnaces have been lighted for some few weeks for a few preliminary tests, and have been found to be generally satisfactory, but few small modifications having been necessary to suit the character of the material delivered. The Hearts of Oak Society have at last overcome the scruples of the Vestry, for by 40 to 6 it has been decided to give the society permission to have a service pipe laid from the Hydraulic Company's mains on condition that the power is used for no other purpose than for a lift, the Vestry being desirous of protecting themselves against any possible use of the power for the manufacture of electricity.

Berkhamsted. — The chairman of the Great Berkhamsted District Council has received the following letter: "Bedford Electric Light Company, Limited, 3, St. Paul's-square, Bedford, September 13, 1895.—Sir,—As far as I am aware, no action has been taken by your Council with regard to the notice of the proposed application by this company to the Board of Trade under the Electric Lighting Acts, 1882 and 1888, for a provisional order to authorise the introduction of the electric light at Berkhamsted. I am now instructed by my directors to open negotiations with your Council with a view to obtaining their consent to the proposed application by this company. In making this application my directors do not think it desirable to suggest any terms upon which they are willing to undertake the lighting; but if your Council entertain the application to leave them to grant to them their consent upon such conditions as they consider desirable in the interest of the neighbourhood to be lighted and fair to the undertakers. My directors, however, wish me to inform you that they are prepared to meet the views of your Council in every way they possibly can —Your obedient servant, W. Jessop, secretary. F. Q. Lane, Esq." No action was taken by reason of no specific application being placed before the Council, but it was agreed that there was no objection to the electric light company applying to the Board of Trade in the matter as it referred to the roads.

Sunbury-on-Thames.—The District Council have received a report from Mr. Anstie, engineer to the Council, with reference to the suggested scheme of sewage pumping by electricity, the scheme having been patented by Mr. H. South. The report dealt with each detail supplied by Mr. South, and Mr. Anstie pointed out that whereas the electrical machinery was estimated to cost £5,000, against Mr. Anstie's scheme, £7,860, there were several omissions in the former estimate which it was calculated would increase it to £6,244. The annual outlay in connection with the electrical scheme would, it was stated, prove as expensive as the ejector scheme, and Mr. Anstie questioned whether the Council were justified in trying the experiment in such an important district. He further gave his opinion that the Local Government Board would not sanction the expenditure on the electric scheme in lieu of the one they had already sanctioned. The clerk read a further letter received from the Local Government Board acknowledging the Council's reply, and asking upon what points they had asked the engineer to report. The Board wished also to know what steps the Council had taken to acquire land in regard to the sewerage scheme, and desired an immediate answer. It was eventually agreed that the clerk should reply that pending the report of the engineer no steps had been taken, and send Mr. South a copy of the report, and that it should be further considered at the next meeting.

Leicester.—Councillor Clarke read at the last meeting of the Town Council a memorial from the electrical engineers of the town asking the Council to seriously consider the action of the Electric Lighting Committee in connection with the trade of fitting electric light installations. The Corporation, they stated, had created a competition between themselves and the petitioners which threatened to overwhelm their trade as contractors, and was stifling that healthy competition between local electricians which would otherwise exist for the benefit of the public. They therefore prayed that the committee might be instructed to refrain from competing with the local trade in fitting electric light installations. He moved that the petition be referred to the committee. Alderman Sir Thomas Wright seconded, and it was agreed to. In moving the adoption of the electric light report. Alderman Lennard said the income had been £963, including £268 for the fittings business. The expenditure, apart from interest and sinking fund, was £863, showing a profit of £100 on the revenue account, although it was not till late in the winter season that they got to work with it. But after deducting the interest and sinking fund there was a balance of £951 on the wrong side for the half-year. That was a large amount, but he would prophesy that when he made his next half-yearly report the balance-sheet would be pretty well even after paying the sinking fund. The actual loss on working now was only about £400, £700 of the total deficiency being on account of sinking fund.

Edinburgh.—The Cleaning and Lighting Committee of the Town Council have agreed to recommend that the West Bow and the Grassmarket should be lighted by electricity, and also to erect electric lamps at the corners of Picardy-place and London-road. The committee further recommended that until some definite scheme of extension is resolved upon, the request of the proprietors in Castle-terrace for the lighting of that thoroughfare by electricity should not be entertained. The Edinburgh Electric Lighting Committee decided on Tuesday upon the Brockie-Pell electric lamp for the lighting of Charlotte-square, George-street, St. Andrew-square, and the streets leading up to them from Princes-street. It appears that the former contractors could not undertake to supply the present style of lamp at the old price. The committee had likewise under consideration the matter of the frequency with which breakages of public electric lamp globes are brought to the notice of the staff. It seems that of late breakages have been reported so often that the suspicion is entertained that they are not caused by legitimate wear-and-tear, but are the result of wilful mischief on the part of persons using catapults. As these electric light globes are specially manufactured in Austria, and cost about 9s each, the matter is regarded by the committee as by no means a trifling one. As the result of the meeting, instructions were given to the police to take special precautions to detect and punish offenders The hope was further expressed that the public would assist the authorities in the matter by preventing or reporting cases of wilful damage.

Bedford —A correspondent writes: That the action of the Town Council with regard to the institution of the electric light in Bedford was the right one, has been satisfactorily proved by the ever-increasing demand which is being made upon the resources of the electric light station. Although the long evenings and short days are not yet upon us, it has been found necessary to increase the power of supply, and considerable alterations are now in progress at the central station at the Caldwell Bridge. When the building was planned and erected about a year ago the possibility of extension had to be considered, and it was arranged that the building should be blocked at either end with temporary walls so that at the proper time additions could be easily made The two new alternators are of much larger and much more powerful design by Messrs. Siemens Bros., though the type is similar to those at present in use. A substantial bed of concrete is being prepared for their erection. and it is expected that when they are in working order they will be able to manage three times the load which taxes their resources. There will be room for a third if it is required. The boiler-room, situated on the side nearer the river, is also being greatly enlarged, and new Scotch furnaces are in course of erection The additions have added much to the appearance and importance of the electric light station and it is expected that the additional power will enable them to meet all the demands made upon the light during the coming winter at least. The electric light has found excellent customers amongst the principal shops of the town. The Corn Exchange uses about twice as much as the Town Hall, and now that several of the clubs of the town have been connected there is a considerable increase in the consumption. The extension of the mains in the Cardington-road district has resulted in a call from many private residents, while something may be expected from Midland road, where work is in progress.

St. Helens.—Mr. F. H. Tulloch, an inspector to the Local Government Board, held an enquiry at the St. Helens Town Hall, on Tuesday, on the application of the Corporation to borrow £10,000 for the purpose of the electric lighting of the main streets in the centre of the town. The case of the Corporation was laid before the inspector by Mr. W. J. Jeeves (town clerk), who said the Corporation owned the gas undertaking, and had therefore a special interest in keeping control over the electric lighting. In former years there had been applications by various companies for provisional orders authorising them to supply electricity within the borough, which had been consistently opposed by the Corporation, as they felt that they ought to have control themselves, and believed the time had not come for the installation of the light. In 1894 they considered that they ought to have power to put down an installation, and they, therefore, applied for a provisional order, which was granted, and it was under the provisions of that order that the application was being made. They proposed to put down an installation at the gasworks, and from there lay a cable through Corporation-street to the corner of Hardshaw-street, where a new technical school and free library was being erected, which would require to be lighted with electricity. The plant the Corporation were putting down would be sufficient to light the public buildings referred to and to supply any demands for electric lighting likely to be made within the immediate future, and it was to be so arranged that while sufficient for present purposes, it would be capable of extension should demands warrant it. In reply to the Inspector, the Town Clerk further stated that the contracts for the plant had been let subject to the approval of the Local Government Board. Mr. Peter M'Kinley, a town councillor, said he was not altogether opposed to the electric lighting, but he protested against contracts being given out before the consent of the Local Government Board had been obtained. There had been a lot of trouble about the same thing in years gone by, and the Corporation gave an undertaking to the inspector that they would not do it again. The Inspector replied that the contracts on the present occasion were let subject to the approval of the Board, and were not accepted or given out in the ordinary meaning of those words.

Yeadon.—The property owners and ratepayers of Yeadon have met in order to consider the following resolution: "That the Yeadon Urban District Council adopt the electric light for the purpose of lighting the district as provided in the provisional order obtained for same." Mr. Medhurst, electrical engineer, of London, who has been called in by the District Council to advise on the tenders sent in, said he recommended the Council to accept the tender and scheme of the Brush Company. This

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amounted to £5,487, but the tender did not include buildings, foundations, connections with the consumers' premises, excavating and making the roads good again, sundry charges, contingencies, etc., which he had estimated at £1,795, thus bringing the total cost up to £7,282 The plant was to be equal to supplying 1 800 lamps, besides 146 street lamps, and although the undertaking would not quite pay interest and sinking fund during the first and second years, he believed that in subsequent years there would be a surplus. The charge proposed to be made was 10s. per lamp per year. A number of questions having been asked and answered, addresses were given by several numbers of the Council. Messrs. J. Flaxington, H. Marshall, and Tony Marshall spoke in favour of the Council adopting the light, the two former giving a number of statistics in support of their contention that the undertaking could be made a paying concern. On the other hand, Messrs. Hudson (chairman of the Council), Cooper, Jenkinson, and Bolton condemned the proposal, holding that it would be a burden on the rates. Mr. Jonathan Peate said that if the Council were expecting to light the mills with the electric light he was afraid they would find themselves mistaken, as the mills, having their own power, could produce the light on terms far more advantageous than could be given to them by the Council. He did not therefore see how in a scattered place like Yeadon they were going to get 1,800 lamps. He was not against the adoption of the electric light at some future time, but he argued in favour of delay. A resolution having been proposed and seconded that the Council adopt the light, Mr. Peate moved an amendment that the question be deferred for three months, and that in the meantime the District Council ascertain what number of lamps they could get taken up. The amendment was carried.

Copper.—More than usual interest attaches to the latest monthly statistics of the copper trade, says the *Financial News*, owing to the fresh batch of rumours with regard to the proposed arrangement for regulating supplies, and to the active demand for copper shares to which the rumours have led. For more than a twelvemonth past there has been much talk about the intentions of the producing companies and from time to time it has seemed as if the negotiations were on the point of being concluded; but so far, nothing has been settled, though there are many who believe that the latest proposals for a restrictive combination, with the Rio Tinto and Anaconda companies at its head, will shortly be generally accepted. That it would be possible for the principal producing companies to reduce the supplies of the metal, and thus, for a time, at least, to lift the market values both of copper and copper shares, is indisputable; but arrangements for tinkering with the natural laws of supply and demand, however apparently safe and profitable to those who join in them, have a very awkward knack of going wrong, as the experience obtained by the Société des Métaux in 1888 showed very plainly Of course, it will be said that the projected combination is of quite a different character, and that producers have no desire to raise prices unduly, or to bring about anything approaching a corner. With the beginnings of industrial revival in many directions, it is clearly desirable that consumption should be encouraged as much as possible, seeing that the greater the demand the more certain, if gradual, would be the improvement in the value of the commodity. To force up prices by artificial manipulation would inevitably check the demand, and it is obviously better to be able to sell an article freely at £47 per ton than to have it left on one's hands by asking £60 or £70 per ton for it. This being so, it seems to us self-evident that the copper producing companies would act wisely in adopting the policy of *laissez faire*. The consumption of copper is increasing satisfactorily, and it will continue to do so if it be left to take its natural course. That the deliveries of the metal have already got ahead of the supplies is proved by the monthly statistics which have just been issued by the leading firms From the figures furnished by Messrs. Henry R. Merton and Co. it would seem that the total supplies of copper in England and France last month amounted to 8,361 tons, and the deliveries in England and France were 10,950 tons.

South Staffordshire Tramways.—Correspondence between the South Staffordshire Tramway Company and the Board of Trade, on the former's application for the renewal of the license to use steam on their tramway, has been read before the Tipton Urban District Council. The tramway company, in their letter, regretted that the agreement with the Electric Construction Company had not been finally concluded, but they hoped it would be shortly. The portion of the tramway which passed through Tipton barely paid working expenses in the summer time, and in the winter was a source of considerable loss, and, therefore, to some extent increased the difficulties which they would have to surmount in providing an improved mode of traction for the other and more profitable sections of the tramways. Several of the engines had been thoroughly overhauled, in order that they might make less noise and be more safe. That, however, would not impede their progress towards providing an improved mode of traction. A letter from the Board of Trade stated that they were unable to regard as satisfactory the circumstances under which the application was made. They had frequently renewed their consent to the use of steam power on the tramways, notwithstanding the objections of certain of the local and road authorities, in the hope and on the assurance that within a reasonable period an improved system of traction would be introduced. The company had, however, made little progress in this direction. In these circumstances the Board of Trade had had serious doubts whether they were justified in granting any further extension of the authority to use steam power, but having regard to the consensus of local opinion referred to in Major Marindin's report of January 31 last that it would be detrimental to the interests of the public if the tramways cease to be worked, they had decided to give a final opportunity to the company of establishing a proper system of traction, and thereby avoiding the contingency referred to. Authority to use steam power would be given until the end of the year, but no application for a further extension would be considered unless either the company were able to satisfy the Board of Trade that arrangements for improved traction were actually in progress, or the local and road authorities supported the application, giving adequate reasons for their support. The Chairman said he should like to know if the tramway company could not possibly, at the end of the year, adopt another form of traction, and their only alternative would be to stop running, whether the Council would sanction the closing of the tramway or not. Councillor Doughty said Walsall, Wednesbury, West Bromwich, and Dudley would be sure to be in favour of continuing the trams, because they took people into these towns for business purposes. Tipton was not so favourably situated—in fact, the people went out of Tipton. He objected to overhead wires as being more dangerous than the steam-engines. He was in favour of the cable. Councillor T. H Millington said he had heard of complaints from Tipton people of the trams taking the money out of the parish, and there were those who would hail with delight the entire stoppage of the trams. Councillor Doughty proposed that the Council, at the end of the year, oppose the running of the steam-engines under any circumstances. Councillor Earp thought they should not be too eager to take action against the company. If the Tipton shopkeepers could not compete with shopkeepers in other towns, and so keep the people at home, they had better shut up. The cable system would be useless at Ocker Hill. They allowed the canal company to raise bridges, but because the tramway company was a weak one they tried to put their foot on it. The Chairman objected to that. The steps they had taken were in the interests and for the safety of the public. He thought they had been very patient with the company. Councillor Butler was of opinion that overhead wires were worse than steam-engines. Councillor Round: Those who drive would sooner meet a steam tram than pass the overhead wires. Councillor Walker proposed that if they were unable to get the cable tramway they should favour the existing steam trams. Councillor Earp: I should like to know what it has cost the tramway company in law expenses. Ultimately it was decided to object to the running of the steam trams at the end of the year.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6½
Brush Company, Ordinary	3	1½-1⅝
—— Non. Cum., 6 per cent. Pref.	2	1⅝-2
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5½-5⅝
Chatham and Rochester	—	—
Chelsea Electricity Company	5	7-7½
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	14½-15½
—— 5 per cent. Debenture Stock	100	133-137
City and South London Railway, Consolidated Ordinary	100	38-40
—— 4 per cent. Debenture Stock	100	134-136
—— 5 per cent. Pref. Shares	10	14½-15½
County of London and Brush Provincial Co., Ordinary	10	8½-9½
—— 6 per cent. Cum. Pref.	4	6½-7½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1-2
Edison and Swan United Ordinary	3	2-2½
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅝-¾
—— 6 per cent. Debentures	—	95-100
—— 7 per cent. Cumulative Pref.	2	2½-2½xd
Elmore's Copper Depositing	2	⅜-1
Elmore's Wire Company	2	¾-1⅛
Fowler-Waring Cables	5	¼-⅜
W. T. Henley's Telegraph Works, Ordinary	10	12½-13
—— 7 per cent. Preference	10	15½-16½xd
—— 4½ per cent. Debentures	100	104-107
House-to-House Company, Ordinary	5	4-4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	19-21
—— 4½ per cent. Debentures	100	100-102xd
Kensington and Knightsbridge Ordinary	5	8-8½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅞-8½
Liverpool Overhead Railway	10	12½-12⅝
—— 5 per cent. Pref.	10	16-15½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric Supply	5	⅜-½
Metropolitan Electric Supply	10	11⅞-12½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-119
National Telephone, Ordinary	5	6½-6⅝
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Non. Cum. Third Pref.	5	6½-6½
—— 3½ per cent. Deb. Stock	100	106-108
Notting Hill Company	10	8½-9½
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	5	7½-7⅝
—— £4½ shares	4½	6-6½
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-105xd
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8-8½
—— 7 per cent. Pref.	5	9-9½
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4⅜-4⅝
Westminster Electric Supply, Ordinary	5	8½-9
Yorkshire House-to-House	5	6½-7

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NOTES.

Guatemalan Telegraphs.—A statement just published shows that Guatemala has 409,769dol. invested in Government telegraph wires, and employs 469 operators.

North-East Coast Institution.—A conversazione in connection with the North-East Coast Institution of Engineers and Shipbuilders will be held at the Assembly Rooms, Westgate-road, Newcastle, on October 18, at 7.30 p.m.

Non-magnetic Metal.—*L'Eclairage Electrique* says that steel containing 12 per cent. of manganese is not magnetic, and that therefore this property could be utilised with advantage in the construction of many electrical apparatus.

Threshing Grain by Electric Transmission of Power is at present being carried on with very satisfactory results at Mjölby, in Sweden. The electricity is conveyed a considerable distance from the main cable to a motor in the immediate vicinity of the thresher.

Electricity in Russia.—The Russian Government has established in Lugansk, in the province of Ekaterinenburg, a cartridge factory, with an annual capacity of 100 million small-bore cartridges. It is stated that 1,000 men are employed at the works, in which electricity is used as motive power.

Incandescent Lamps and Eyesight. — Dr. Gebhardt, of Budapest, has raised an emphatic protest against the practice of putting electric incandescent lamps at a low level among the wares in shop windows. He says this is exceedingly destructive to the eyes, and that these lamps should always be put out of the direct range of vision.

Traction Trials in Berlin.—The *Elektrotechnischer Anzeiger* (October 6) announces that the municipal authorities of Berlin have resolved to grant a credit of 50,000 marks (£2,500) for the purpose of carrying out experiments with various forms of traction, more particularly with the Serpollet steam car, the Dessau gas car, and the improved accumulator systems.

The Tesla Patents.—MM. Schneider and Co., of Creuzot, who alone hold in France the Tesla patents for electromotors with rotary field, have taken proceedings against MM. Weyher and Richemond, who make the Brown motors; MM. Guitton and Bertolus, who manufacture the Oerlikon motors; M. Joly, the representative of M. Alioth; and the Société Grenobloise, for alleged infringement of patents. In Germany, the Actiengesellschaft Helios of Cologne possesses the Tesla rights, and it has acted in a similar manner.

Electricity as an Aid to Navigation. — The inland steamer companies in Calcutta acknowledge the utility of the electric light as an aid to navigation. Several vessels of both leading companies have already been fitted with installations, and the Rivers Steam Navigation Company is having others of its boats electrically equipped this season in order to contend with the expected heavy jute business. These steamers will then be able to run at night and do the distance between Naraingunge and Calcutta in about four days, whereas the trip ordinarily occupies from eight to ten days.

Royalty and the Electric Light.—The other week an alarming report was circulated, only to be immediately contradicted, as to the abhorrence in which Queen Victoria held the electric light. Now we are informed, doubtless on equally reliable authority, that the Empress of Austria has "a positive horror" of the same illuminant—indeed, of gas also—inasmuch as she "forbids the use of anything but the purest wax to light up the palace; and it is," we are told, "very amusing to see the servants, to whom the half-burned candles belong by right, make a rush to blow them out the moment the last guest has walked out of the rooms."

The Institution of Junior Engineers.—At the annual general meeting of this institution at the Westminster Palace Hotel it was stated that the membership roll had increased by 45, the total at the present time being 418. The Belgian summer meeting was, it appears, highly successful. The institution premium for the best paper read by members during the session has been awarded to that on "The Warming of Buildings by Hot Water," of which Mr. E. King and Mr. Kenneth Gray were joint authors. On Thursday, October 17, at 6.30 p.m., a visit will be paid to Messrs. Caird and Rayner's works, 777, Commercial-road, Limehouse, E.

Personal.—The third electrical engineer appointed by the Hull Corporation is Mr. Adam Sedgwick Barnard. Mr. Barnard is 27 years old, and at present is electrical engineer to the Town Council of Lancaster. There he has had entire charge of the electrical supply undertaking, which position he has held since the commencement of the works in 1893. He designed and carried out several extensions of the system, and is now engaged in laying a number of new distributing-mains. Mr. Barnard has been solely responsible for the street electric lighting of Lancaster, as well as for the bulk of the private lighting, which he has carried out with his own staff.

Train and Tram Lighting by Electricity.—Lighting railway carriages by electricity, the *Railway Engineer* says, is to have another trial, and this time with every prospect of success. The London, Tilbury, and Southend Railway Company, after having made extended trials with the system which is being introduced by Messrs. J. Stone and Co., of Deptford, have decided to electrically equip two additional trains. The Midland Company and the Midland Great Western of Ireland are also giving extensive trials to this system. The North Metropolitan Tramways Company, again, are adopting the electric light experimentally, several of their cars on the Aldgate and Stratford route being already fitted with electric lamps.

Nature's Lightning-Rods.—M. Oovaroff, the Russian electrician, of Moscow, and Prof. Hirscht, Government forest inspector, of the same city, have published some investigations concerning the liability to lightning-stroke of certain species of trees. In the summers of 1893 and 1894 the two scientists spent 109 days in the great forests between Moscow and Remereff, and during that time found 597 trees that had recently been struck by lightning. Of the total number of marked trees 302 were found to be white poplar (*populus alba*), this notwithstanding the fact that that species is not nearly so common as a dozen other varieties. On the suggestion of M. Oovaroff, the Russian Government recommend that the peasants should use it as a lightning-conductor.

Electricity in Mining.—At the annual meeting of the South Staffordshire and East Worcestershire Institute of Mining Engineers held at Mason College, Birmingham, Mr. J. H. Cooksey, the newly-elected president, said that it was imperative that the mining engineer should be equipped not only with a practical acquaintance with mining in all its branches, combined with a considerable knowledge of mechanical science, but also—and the necessity for this was daily increasing—with an acquaintance with the principles of the science of electricity. Mr. J. Meachem, jun., read before the gathering a paper upon "The Electric Power Plant at Haden Hill Colliery, Red

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Hill." He explained that the installation was for the purpose of hauling the coal from the face of the work to the shaft, pumping water, lighting, and ventilating.

An Electric Theory of the Solar System.—M. C. V. Zeuger, professor of astronomy and physics at the Prague Polytechnic School, contributed a paper on this subject at the recent meeting of the Association française pour l'avancement des sciences at Bordeaux. M. Zeuger has been experimenting with a hollow copper sphere suspended in an asymmetric field produced by one, two, or three electromagnetic poles, and finds that the movements of the sphere present an absolute analogy to the motions of the planets. He proposes, therefore, "to replace Newton and Kepler's laws by the law of Gauss." It follows as a consequence of the theory that the periods of revolution of the planets and comets must be a multiple of half the period of rotation of the sun, and a similar law would apply to the revolutions of satellites round their primary, except in so far as they may be affected by perturbations of the sun or other planets.

Books Received.—We have received the third and final supplement to Mr. Henry Sell's "Register of Telegraphic Addresses" for the year, correcting the information supplied to Mr. Sell by the Postmaster-General during the past three months. All the additions and alterations contained in the three supplements of the year and any further corrections and information received from the Post Office during the current three months will, we understand, be incorporated in the new volume for 1896, which will be ready early in January next. The new volume will also contain all the trades and professions, as well as the telegraphic addresses and telephone numbers of the 50,000 largest concerns in the country. In the preface to the supplement will be found some particulars as the extension of telephonic communication between large towns. We have also the programme of the City and Guilds Technical College, Finsbury, Leonard-street, City-road, E.C., session 1895-96.

Manufacture of Chloroform by Electrolysis.—It is highly necessary that chloroform should be absolutely pure, for great as are the services that it has rendered to surgery, there is always the risk that the patient may fail to come to if the chloroform used is not quite pure. M. Raoul Pictet claims to have obtained it in a state of perfect purity by distillation at the low temperatures that he has been able to produce. Electricians, however, are setting up against this purification process a method of manufacture which gives quicker results. A double-headed retort of enamelled iron, heated by steam, and containing two lead electrodes, is filled with a 20 per cent. solution of common salt. The liquid is raised to the boiling point and a stream of acetone is sent in and diffused, the electric current passing at the same time. The chlorine produced by electrolysis reacts on the acetone, and the chloroform obtained is collected by distillation. From 100 parts by weight of acetone, it is stated that 190 parts of absolutely pure chloroform are obtained.

Evaporation in Wet Cells.—A simple method of guarding against evaporation and salt secretions in wet cells is described by Herr Carl T. Fischer in the *Elektrotechnisches Echo*. He remarks that the chief disadvantage of open, wet, house batteries, for example, the Leclanché cells, consists in that, in the first place, the liquid is continually evaporating, and that, in the second place, the salt crystallises on the glass. Hitherto, to obviate these difficulties, tallow or asphalte lacquer has been used to coat the upper sides of the cell inside and outside. Herr Fischer uses, after the cells are filled, an infusion of paraffin oil, which, of course, floats on water, to the depth of one or two centimetres. He says that he has successfully employed this paraffin deposit for three years both with batteries and small accumulators. Paraffin oil is the best substance to use, because it may be exposed for years to the atmosphere without becoming rancid. The oil deposit at once absolutely prevents evaporation, since no air can get to the liquid, and paraffin oil itself does not evaporate. Crystallisation of the salt out of the liquid is also prevented.

Sealing Champagne Bottles Electrically.—In a recent number of *La Nature*, M. A. M. Villon describes a novel method of sealing champagne bottles. The loss and deterioration of champagne due to the escape of gas has long, he says, made some process of perfect air-tight sealing desirable. M. Villon accomplishes this by covering the cork and part of the neck with a thin layer of copper electrically deposited. For this purpose the neck of the bottle is coated with a conducting substance such as black-lead, zinc or copper powder, and plunged in a galvanic bath. This bath has a cover of paraffined wood with conical holes, which are lined with copper rings. All these rings are connected among themselves, and with the negative pole of the dynamo, while a copper sheet in the bath is connected to the positive pole. The bottles are simply inserted in the holes, neck down, and when a layer of $\frac{2}{10}$ to $\frac{3}{10}$ of a millimetre has been deposited the current is stopped. The deposit may be gilt or silvered, or given any desired shade in special baths. The process, of course, can be employed to seal bottles for mineral waters, preserves, and a variety of products.

Telegraphs on the Amazon.—With reference to the paragraph under this head in our issue of September 27, p. 337, we are further informed that the entire length of the route for the new cable about to be laid up the Amazon from Pará to Manaos under exclusive concessions from the Government of the Brazilian Republic is 1,365 nautical miles, and that there will be in all 16 stations on the line. The "Faraday," it is stated, will probably leave England next month with the cable, more than half of which is already manufactured. This long subfluvial line will for the first time bring these tropical regions, so increasingly productive of indiarubber, coffee, and sugar, into direct telegraphic communication with Europe. All past attempts on the part of the Brazilian Government to establish aerial lines through these districts have, it appears, failed, owing to the rapidity and density of the forest growths. Mr. Reidy, representative of the Amazon Telegraph Company, joined the expedition at Pará. The great importance of the Amazon as a trade route may be gathered from the fact that the "Faraday," a steamer of 5,000 tons burden, will proceed all the way up to Manaos, a distance of 1,100 miles from the mouth of the river.

Electricity v. Horses.—From the *Field* comes a wail of complaint that "the horse is likely to become extinct in the United States, or at all events to be seen only in museums and menageries. Electric traction has undergone surprising developments in that country, thus displacing horse power, which fails to find employment in other ways. The latest official reports show that over 10,000 miles of electric roads, with a total capitalisation of nearly 1,000 million dollars, are actually in working order, and that electricity is the motive power of no less than two-thirds of the gigantic number of street cars actually in use. In this connection it is important to remember that any town with at least 5,000 population in the United States would consider itself disgraced if it had not a public street car service. It is estimated that up to the present time 50,000 horses have been displaced upon the tramways. Nor is this all, for the extensive system of suburban and

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country lines has made it needless for many families to keep a horse and carriage who once thought it necessary. Then, again, the horse, driven out of the tramways, driven out of the private carriages, finds a new competitor in the bicycle, which threatens him with actual extinction." The same doleful predictions about the noble animal were nevertheless everywhere heard on the introduction of railways.

Niagara's Fate.—The commissioners of the Niagara State Reservation have appended to their annual report an essay on the subject of the famous Falls by Prof. J. W. Spencer, who observes that the computation of the age of the Niagara River—based upon the measured rate of recession during 48 years, upon the changing descent of the river from 200ft. to 420ft. and back to 320ft., and upon the variable discharge of water out of the Erie basin only during three-fourths of the life of the River, and afterwards that of all the upper lakes—leads to the conclusion that the Niagara Falls are 31,000 years old, and the river of 32,000 years' duration; also, that the Huron drainage turned from the Ottawa River into Lake Erie less than 8,000 years ago. If the rate of terrestrial deformation continues as it appears to have done, this authority calculates that in about 5,000 years the life of Niagara Falls will cease. These computations are confirmed by the rate and amount of differential elevation recorded in the deserted beaches. It is further roughly estimated that the lake epoch commenced 50,000 and 60,000 years ago, and there was open water long before the birth of Niagara in even the Ontario basin, and that under no circumstances could there have been any hydrostatic obstruction to the Ontario basin since before the birth of Niagara Falls.

The Otto Apparatus for Producing Ozone.—The action of the ozonising apparatus invented by M. Otto is based on the partial transformation of oxygen into ozone under the influence of a continuous discharge. The ozoniser is enclosed in an oblong wooden box coated inside with a protective lacquering, which prevents the corrosive action of the ozone. The box rests on four glass feet. Inside there is a series of triple plates made up of two plates of glass, enclosing a sheet of aluminium foil or some other conducting material. The plates are perforated with several holes alternately at the top and at the bottom to allow the gas to pass. The end plates have only one hole each for the entrance and exit of the gas. Thin strips of asbestos at the edges of the glass plates keep them at a uniform distance of a millimetre from each other. To keep the system gas-tight, the two end glass plates are made slightly larger than the others, and the space left at the periphery of the others is luted with a suitable cement. The conducting plates are connected alternately odds and evens together by little tags, and the ends of each set coupled up to the terminals of a Rhumkorff coil or a high-tension alternator. The discharge takes place in the spaces between the successive plates, the oxygen to be acted on passing in a zigzag course through the holes alternately at the top and bottom of the plates.

The Telegraph Service in Chili.—The Chilian Minister of the Interior reports the reconstruction of 830 miles of telegraph lines during the past year, at a cost of 120,250dol., and the erection of 340 miles of new lines at a cost of 87,641·50dol. Forty lines, moreover, were repaired, at a cost of 10,128·50dol. With this outlay the service has been much improved. Direct communication between the principal offices has been completely established, whilst in the secondary offices the system of turns has been abolished. Previously these turns were a necessity owing to a deficiency of lines. One line more between Serena and Illapel, and the reconstruction of the line between those places, will, the Minister says, complete the telegraphic network of the Republic, and will be sufficient for all present necessities. In 1894, 12 new offices were opened, and three were closed for want of business. The number of messages transmitted in 1893 and 1894 shows a great increase over 1890, whilst the revenue in 1894 exceeded that of 1890 by 155,431·22dol. Similarly to the State railways, the telegraph lines of the Republic are the result of patient labour extending over many years. The precursor of the network of these lines was the "linea Americana" between Valparaiso and Santiago, which was constructed little more than 40 years ago, and as a company concern proved a failure. In Chili, as in England, telegraphs and post office are generally mentioned together, and the Minister reports a large increase in the business of the latter service.

Retirement of a State Telegraph Engineer.—Mr. J. E. Naylor, assistant-superintending engineer of the Postal Telegraph Department, has just retired, owing to failing health, from the active service of the General Post Office. Mr. Naylor has been associated with the electric telegraph for a period of 40 years, during which time he has taken an active part in the extensive work that has devolved upon the engineering department in connection with the extraordinarily rapid development of telegraphy, especially during the last quarter of a century. Joining the British Telegraph Company in 1855, Mr. Naylor was appointed clerk-in-charge of that company's office at Wakefield in 1860, and five years later he was promoted to a similar position at Sheffield. In 1868 Mr. Naylor became an inspector of the engineering department and had charge of all the Magnetic Telegraph Company's wires and apparatus upon the Lancashire and Yorkshire Railway, from Sowerby Bridge to Goole and Leeds, and also upon the South Yorkshire Railway from Barnsley to Sheffield and Doncaster. On the transfer of the telegraphs to the State, he was appointed to the York district, and carried out the extensive erections of new road lines that were then made from Beverley to Scarborough and Whitby, and from Leeds to Harrogate and Northallerton. On the rearrangement of districts that took place in 1878, Mr. Naylor was appointed to Leeds, where he carried out extensions and additions rendered necessary by the adoption of the sixpenny rate for telegrams. More recently he has taken an active part in the erection of the new trunk telephone lines that have been erected by the Post Office.

A New Form of Insulator has been devised by Messrs. Albert Vickers and Wm. Dibb, of Syracuse, N.Y. The insulator, the *Electrical Review* of New York says, is designed to do away with tie-wires. The idea to aim at in effecting a perfect support for any wire is to prevent its coming in contact at the insulator with anything that could injure it in consequence of the constant movement that exists there owing to swinging in the wind of the wires and working of the poles. In the insulator under notice the idea has been to support and fasten the wire and yet have it in contact with nothing but smooth rounding surfaces of glass or porcelain which could not possibly in any way injure it. The insulator consists of a body of the present form screwing to the pin with the top part provided with a cavity. The roller action of the plug prevents the wire from moving laterally, the plug keeps it from flying up, and it is therefore securely fastened. The plug cannot come out, for the pressure of the wire against a slight groove in it holds it to its place securely enough, as there is no strain on it tending to force it out. In addition to the advantages

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already cited, the following points are claimed for the insulator: It fastens the wire more positively than a tie, and all corrosion is avoided. It is used more easily and quickly than a tie, and can be fastened very much more quickly. This saves time and money in constructing lines and the results are bound to be more satisfactory, as every fastening is uniform and is readily inspected from the ground, since if the plug is in position the fastening is all right. It is evident, therefore, our contemporary adds, that broken wires and crossed lines will be at a minimum on lines where this insulator is used, to say nothing of the very much less time required to construct a line with them.

Fog-Signalling by Searchlight.—There has been a discussion in the *Standard* as to the first inventor of fog-signalling by searchlight. Mr. Ronald A. Scott, M.I.E.E., writes, in reply to a letter by Mr. Nelson Harris, of Deal, that the intensity of a 6,000-c.p. searchlight would be insufficient to render a beam visible at 33 miles distance. It was this fact, he says, that caused Lieutenant Froude, R.N., to ask him to assist him with his (Mr. Scott's) powerful searchlight in his experiments, as the tiny one in use during the mimic sea battle, though, of course, capable of throwing a small vertical beam, was practically useless for the purpose of Lieutenant Froude's investigations. It will be apparent to anyone, he thinks, that, if the beam of light was seen at a distance of 33 miles from the exhibition, it was, doubtless, thrown from Mr. Scott's projector of upwards of 27,000 c.p., and not from one of only 6,000 c.p. Mr. Harris replies that as Mr. Ronald Scott indirectly concedes the point that he has been fighting for, that Commander Wells was the first to adapt a searchlight for the purpose of deflecting a beam of light vertically, he does not propose to go any further. He admits that it is more than probable that it was Mr. Scott's light that was observed at Frant. He adds that, from circumstances that have since come to his knowledge, it is possible that his claim for Commander Wells will have to be abandoned in favour of a commander in the Eastern Telegraph Company's service, who, he has been informed, was induced to make experiments with a searchlight at Malta and Gibraltar so long ago as in 1886, through having observed that the glare, or reflected light, of the Lizard light, sent horizontally, was visible at a distance of 50 miles. Had a light of such intensity been purposely directed vertically, it is difficult, he imagines, to say at what distance it might not have been seen. Unfortunately, Lieutenant Froude is at present absent from England.

Electric Lighting of Tunbridge Wells.—The ceremony of the official opening of the electricity works at Tunbridge Wells was conducted on Wednesday last with unusual demonstration. The programme commenced with a gathering of guests in a large hall, where the hospitality of the mayor (Sir David Salomons) was dispensed, after which followed speeches of the usual order. Councillor Ashby Wood, as chairman of the Electric Committee, handed to the mayor the key of the works, after referring in glowing terms to the prospective advantages which would accrue to the ratepayers from the fact of their having kept the electric lighting of the town in their own hands. Sir David Salomons, in reply, stated that the demands for the light had more than fulfilled his expectations, and dwelt upon the advantages to be derived from the use of electricity for public and private purposes. Mr. Preece also spoke, and a vote of thanks was accorded to the mayoress. A procession of the public bodies of the borough was then formed, and proceeded to the central station in the Corporation yard. Here the mayoress switched on the new light, and, after a parade of the town, a visit was paid to an electrical exhibition held at the Town Hall. This exhibition contains an extremely creditable collection of apparatus and fittings, displays of various apartments artistically fitted with incandescent and arc lamps, heating and cooking apparatus, ventilating fans, telephones, bells, cigar lighters, night lights, together with a host of minor novelties to which the energy of current force is now applied; and the mayor has equipped a stand with a highly interesting set of scientific appliances. In addition to a large number of local firms several London houses send exhibits. One of the most attractive displays is a happily-conceived design of partly-concealed and variously-coloured lights embowered in fernery, foliage, and rockwork.

Compulsory Use of Fenders.—The Massachusetts Board of Railway Commissioners has promulgated the following order requiring street railway companies to equip their cars with fenders: "All cars run by a street railway company on a highway, townway, or travelled place (excepting cars run by horse power, cars run only as trailing cars, and, until the further order of the Board, cars run wholly within the limits of towns whose population is less than 7,500 each), shall be equipped with fenders and wheelguards in accordance with one of the two following methods: either (1) with a fender at the front of the car (going in either direction), and also with wheelguards underneath the car; or (2) with a fender at the front of the car of such design as to serve also as a wheelguard. In the first case (1) the fender shall consist of a platform, netting, or other similar device, constructed and arranged so as with reasonable certainty to pick up a person who is run into while standing, but to pass over a person who is lying on the ground, without probable injury to the person in either contingency; and the wheelguards shall be of such construction and arrangement or method of operation as to prevent, so far as practicable, a person who has fallen or been thrown down from being run over by the wheels. In the second case (2) the fender shall be of such construction, arrangement, and method of operation as not only to pick up as aforesaid a person who is run into while standing, but also to prevent, as far as practicable, a person who has fallen or been thrown down from getting under the car and being run over by the wheels. This form of fender shall accordingly include a device by which, in case of emergency, it can be lowered by the motorman, and when lowered held down close to the ground." These regulations are to take effect on November 14, 1895. The Board of Railroad Commissioners of Massachusetts enjoins, furthermore, that the several street railway companies shall equip such electric box cars as are used by them for the transportation of passengers in the months of November, December, January, February, or March in each year, with suitable apparatus for heating them by electricity.

"That Terrible Telephone."—In the course of a leader with this title the *Financial Times* remarks: In order to give the telephone a fair trial we made an impromptu experiment last night from the offices at which this journal is printed, two members of our staff joining in the trial, having separate receivers attached to the same instrument, and adhering rigidly to the printed rules. In the first instance, after listening for a reply from the exchange, and getting it, we were asked for the number of the subscriber wanted, and gave that of our City telephone. Nothing happened for some little time, and then the operator remarked, "Well?" It turned out that she had not heard the reply. Finally, communication was established in the strictly limited sense of the London telephone—that is to say, it was clear to the subscriber at each end of the wire that somebody was talking to him

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from the other end. But intelligible conversation was found impossible, even to the extent of explaining the object of the call. While efforts to this end were in progress, our representatives learned with interest that somebody unknown was "wanted at the Adelphi," together with a quantity of other information which was only relevant to the object of the call in that it emphasised one of the most glaring defects of the system. Next we tried Brighton, and asked for the Métropole Hotel there. The reply came promptly that we could not be put through, and our natural rejoinder was, "Why?" The operator promised to enquire, thereby breaking one of these precious rules, which says "that the operators are strictly forbidden to answer any question." We should feel very thankful if conversation between subscribers were as clearly audible as was the altercation which ensued between the operator who had said we could not get through and the one who had conveyed us the message. Ultimately we were told it was a mistake arising from an idea that our printing works were a hotel. Why that should have prevented our talking to another hotel, we know not; but such was the explanation given. After a little more delay, we were asked if we knew that there would be a charge of a shilling; and having satisfied the exchange that we were willing to risk that sum, the desired communication was effected. From Brighton every word was audible, in spite of the conversation which was going on at the same time on the London wires as to a place of amusement for the evening. This experiment was quite unpremeditated. Our representatives did their best in every way to give the telephone and its operators a fair chance. The results as above stated are in no way exaggerated; nor are they an exceptional experience. Surely there must be some remedy for this sort of thing.

The Paris Municipal Regulations for Indoor Electrical Installations, which were recently issued, are embodied in 16 clauses. No. 1 enjoins that electric installations supplied by a concessionee of the city of Paris must satisfy the conditions laid down both at the time of their establishment and at any period of their use. No. 2 sets forth that the metal entering into the composition of the cables and wires must be of a resistance equal at most to 1·8 microhm-cm. at 20deg. C. No. 3 is as follows: The metallic section of the conductors must always be such that the accidental passage of a current of double the normal intensity should not result in a temperature of above 40deg. In every case the current density must not exceed three amperes per square millimetre for sections of 1mm.^{2} to 5mm.^{2}, two amperes per square millimetre for sections of 5mm.^{2} to 50mm.^{2}, one ampere per square millimetre for sections above 50mm^2. (This amounts to about 2,000 amperes per square inch for wires from Nos. 13 to 19 B.W.G., 1,300 amperes per square inch for wires from Nos. 1 to 12 B.W.G., and 650 amperes per square inch for larger sizes.) When bare wires are used the figures indicated should be doubled. No conductor must be used the core of which consists of a single wire of a smaller diameter than $\frac{9}{10}$mm. No. 4.—Outside the switchboards all the cables and wires must be both insulated electrically and protected mechanically. For wires placed in damp situations the covering must be waterproof. No. 5.—The safety fuses must be easy to replace, and must not cause projections of the melted metal. They must fuse at a current of at most three times the normal. No. 6.—The insulating material forming the base of the switches must be suitable to the situation they occupy. They must not be heated by the passage of the current. They must always remain at a temperature that the hand will bear. No. 7.—Each wire of a private connection must be furnished with a cut-out and a switch. No. 8.—When motors, transformers, or accumulators are used, they must be fixed so as to avoid all risk of accident. Special precautions must be taken to insulate them and place them beyond the reach of persons who are not called upon to deal with them. The places where accumulators are located must be suitably ventilated. If there be employed a primary difference of potential exceeding 800 volts for a continuous current, or 500 volts for an alternating current, the secondary installation must be effectively protected against a contact between the two circuits. No. 9.—Each part of an installation must be easily distinguished and insulated from the whole. Each circuit must be provided at the outset with a double cut-out; every lead must be equally so provided, also every sub-division in which the intensity may reach five amperes. No. 10.—The means employed to fix the conductors must both ensure their insulation and avoid damaging the cables or wires; where cables cross, there must be supplementary insulation and mechanical protection. Along walls and ceilings the mechanical protection should be a tube of some hard material with rounded edges. No. 11.—In the portions of cables intended to be united by splicing, the cleaning shall be done with a substance which does not affect either the metal or the insulating material; the use of acids is proscribed. The joints must not weaken either the metal core, nor the insulating covering, nor the mechanical protection. No. 12.—The moulding must have no discontinuity in the angles, curves, and joints. The edges of the grooves must be rounded off at each turn. Cables and wires must never be fixed in the mouldings by means of nails or staples. No. 13.—The greatest care must be exercised in the fixing of electroliers. The conductors attached to them shall have the best insulation and strictly follow the forms of the fittings. In electroliers with five or more lamps, joints must be avoided; the wires of each lamp shall be preferably united to the source of supply on metal crowns furnished with screws. Sockets shall be fixed so that they cannot turn; they should, further, be electrically insulated from the body of the fittings. No. 14.—Each arc circuit shall include a switch, and on each pole a cut-out. If rheostats are used, these shall be placed in a sheltered situation, remote from inflammable material. The wire of the rheostat must not heat above a temperature of 200deg. in ordinary working, and must be separated by an air-gap of at least 5cm. from the wall or the table carrying the rheostats. These fittings shall be mounted on incombustible and non-hygrometric material. No. 15.—When the installation comprises both gas-pipes and electric conductors, the following special regulations apply: (*a*) the fittings serving both for gas and electricity shall always be mounted on a bracket the insulation resistance of which shall be at least 500,000 ohms, and which shall be so arranged that this insulation cannot be impaired by dust and damp; (*b*) wires attached to fittings used for both gas and electricity shall be well insulated and protected from the heat of the gas. Clause No. 16 gives the method of determining the insulation: over every part of the conductor capable of being separated from the system by switching or by the removal of a fuse, the insulation resistance, either with reference to the earth, or to the conductor with the contrary sign expressed in ohms, should not go below $5{,}000\,\frac{E}{2}$, E being the difference of potential in volts measured at the terminals of the generators or current transformers. In measurements of insulation the difference of potential employed must be equal to E, without, however, going above 500 volts or below 100 volts.

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STAFFORD ELECTRICITY WORKS.

There is always a feeling of exultation when we see a historic town acclimatising itself, so to speak, to modern requirements, and thus making continuous its title to enlightenment. We speak about enlightened citizens—up-to-date men, *fin-de-siecle* councils—as indicating that

MR. C. H. WRIGHT, MAYOR OF STAFFORD.

those to whom the name is applied realise the progressive nature of things, that there must be from time to time a putting aside of that which is old and the taking up of that which is new. Stafford comes under this category. It is an ancient town—an historic town, by the Saxons called Stadeford or Stadford, and mentioned in earlier times as

MR. J. FERGUSON BELL, A.M I.C E., ENGINEER OF THE ELECTRICITY AND GAS DEPARTMENT.

Betheney. Subsequently it is described in Domesday Book as having only 18 burgesses belonging to the king, but a larger number looked possibly to the Earl of Stafford as overlord. From the time of the Saxons, too, there was a castle, which was from time to time destroyed and as often rebuilt till demolished by order of the Parliament during the Civil Wars, after which it was only partially rebuilt. An older charter was confirmed and enlarged by King John and again by Edward VI. In 1876 the borough and municipal boundaries became identical. The principal trades of the town are tanning and the manufacture of shoes. Such is the brief history of a town which will

DR. JOHN HOPKINSON, M.A., F.R.S., M.I.C.E., CONSULTING ENGINEER FOR THE ELECTRICITY WORKS.

inaugurate the electric light as a municipal work on Tuesday, the 15th inst.

The history of the electric lighting movement at Stafford dates back to early in 1889, when a provisional order for the supply of electricity was obtained by the Corporation. Mr. J. Ferguson Bell, the gas engineer to the borough, was

ALDERMAN W. H. PEACH, J.P., CHAIRMAN OF THE ELECTRIC LIGHTING COMMITTEE.

then instructed to prepare a report as to the probable cost of laying down an electric lighting plant to supply the scheduled area. Mr. Bell's report was presented to the Council in September of the same year, and it is interesting to note that many of its recommendations have been now carried out. For instance, the advantage of placing the new works on the same site as the gasworks was pointed

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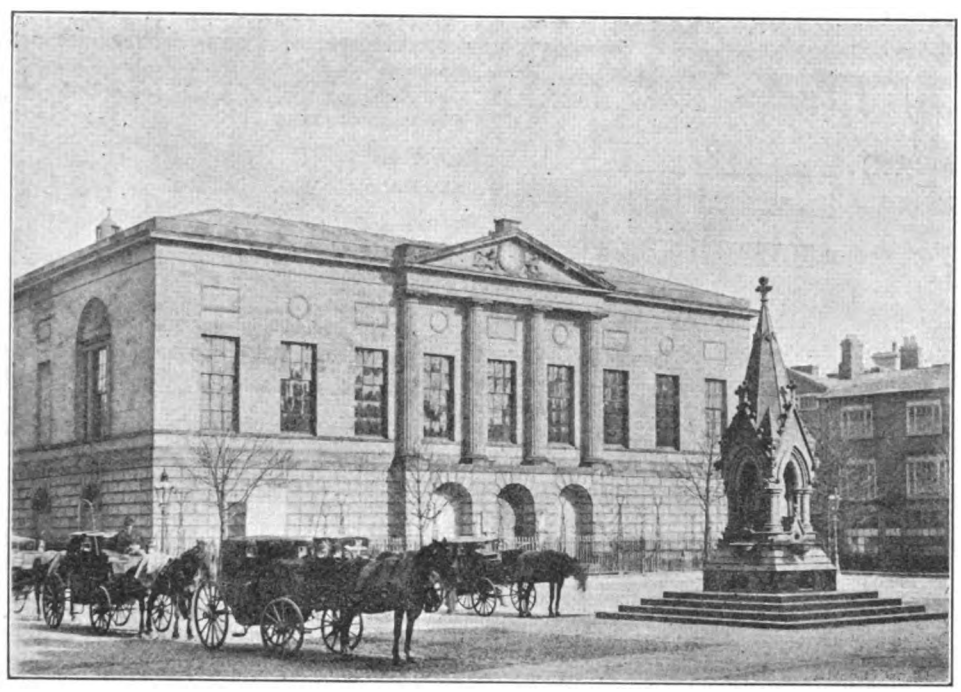
out. The estimated cost, also, did not differ greatly from the cost of the present plant. The following clause, however, shows that the engineer considered caution to be necessary. He stated that: "Unless sufficient consumers can be obtained within the scheduled area who will undertake to pay for not less than six 16 c.p. incandescent lamps each during a period of two years at a fixed price per light, and making an aggregate number of lights equal to 1,200



THE SHIRE HALL, STAFFORD.

16-c.p. lamps, and yielding a revenue of at least £2,400 per annum, the Town Council would not be justified in establishing electric light works." The Council accordingly ordered a canvass of the town to be made to ascertain who would take the light, presumably on the above terms. Anyone who has had any experience of the results of such canvassing will not be surprised to learn that only two townsmen cared to bind themselves for the two years, and hence the matter was allowed to drop for a time. Such has, we believe, been always the case, and no true estimate of the demand can be obtained in a town till the light is actually ready for supply. When, however, the provisional order was about to expire, fresh steps were taken, and Mr. Bell was authorised to obtain further expert advice from Dr. John Hopkinson on the question. The report from this gentleman was received in August, 1893, and since that date the matter has been pushed forward as rapidly as possible.

The following extracts from Dr. Hopkinson's report are of interest to the general reader: "The town of Stafford presents both favourable and unfavourable conditions in regard to electric lighting. Coal is cheap, water for condensation is accessible, and it would be easy for the Corporation to combine in a measure their electric light staff and the staff employed in the production of gas; these conditions all tend to economy of production. On the other hand, the demand for electric light in the town is not likely to be very large, and there will be many consumers whose demand for a supply will last for a short time only, whose account will therefore be small, but for whom it will be necessary to incur considerable expenditure for plant. The first point to be decided is the site upon which the generating machinery is to be placed. In this respect you are fortunate, inasmuch as you have an excellent site at the gasworks which is not likely to be required for the production of gas. This site presents the advantage that, if steam be used, the boilers can be utilised for the purpose of the gasworks when they are not required for the production of electric light. From this will result a considerable economy of coal and wages. The site, too, is in proximity to the district where at first the principal demand may be expected. I am therefore of opinion that there can be no doubt whatever that the gasworks site is the right site for you to adopt. The site for the generating

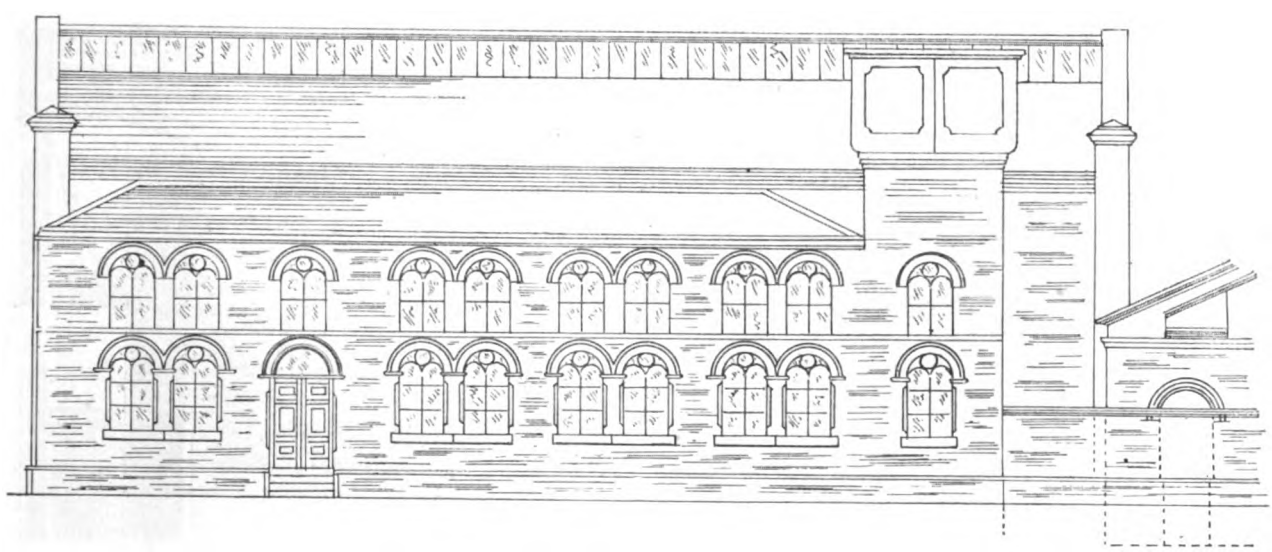


FIG. 1.—Front Elevation of the Stafford Electric Lighting Works.

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plant having been decided upon, the next question is, what is the right system of supply to adopt? The whole of the lighting which you will have to do at first is comprised within a distance of about 700 yards from the generating station. It is now well recognised by all electric light engineers that when the district to be lighted is so near to the generating station, the proper system to adopt is that applied to the supply of mechanical power. I should therefore advise you to adopt the continuous current with the system of conductors known as the three-wire system, which enables you to materially increase the pressure at which you work, and therefore to diminish the size and cost of your conductors. I should also advise you to make use of accumulators. If at a future time a demand for

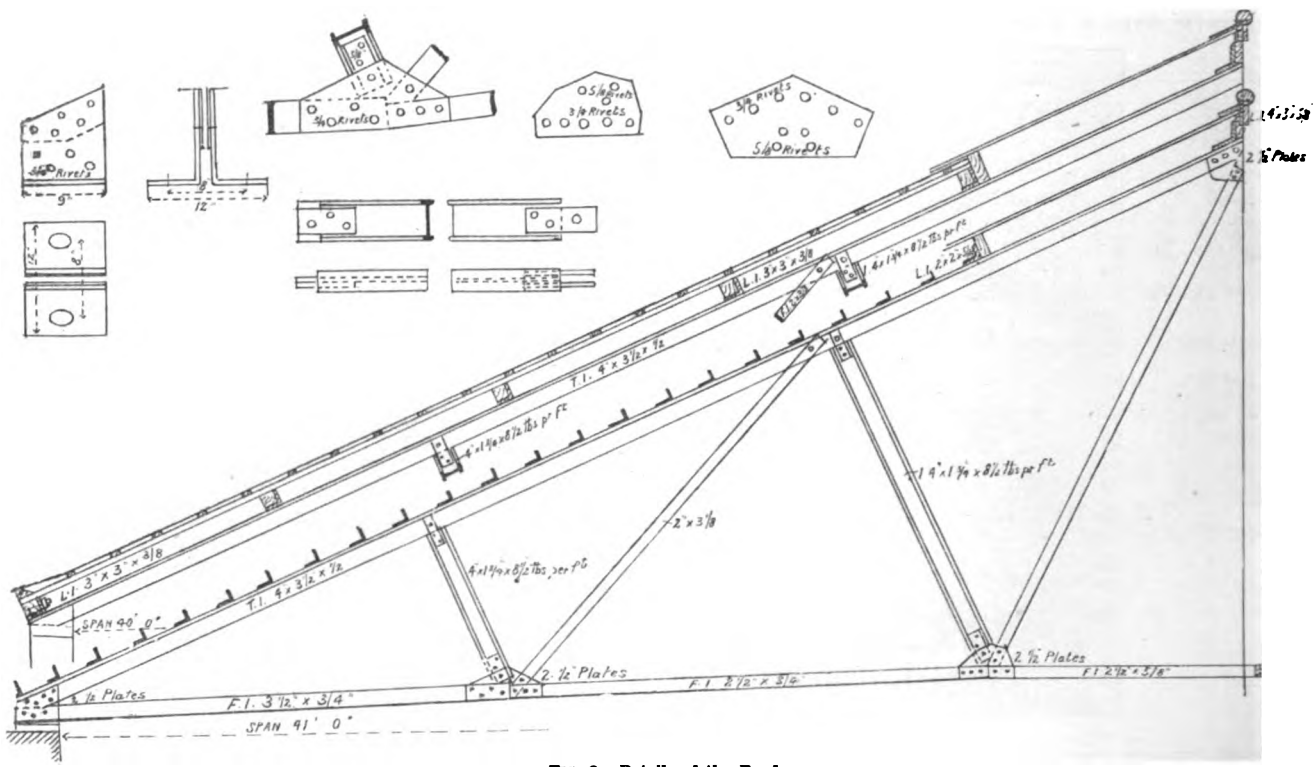

FIG. 2.—Details of the Roof.

with continuous currents at low pressure. The continuous current has the great advantage that with it accumulators may be used. These are continually becoming cheaper, and even at their present price they are of great service in small stations, such as yours will be, in enabling the machinery to be stopped during the greater part of the 24 hours, so economising the wages of the attendants, who otherwise would have to be present for the purpose of supplying a very few lights. They have also the advantage that they enable you to increase to a material extent the maximum output of the station, inasmuch as you are able to add the output of the accumulators to the output of the machinery. The continuous current has the further advantage that it is more readily

electricity arises at a greater distance from the station, this would be met by putting down a battery in the neighbourhood of the demand, and charging the battery from the station directly, if the distance did not exceed a mile, by means of a transformer if it was more considerable. One question still remains—as to the motive power to be used

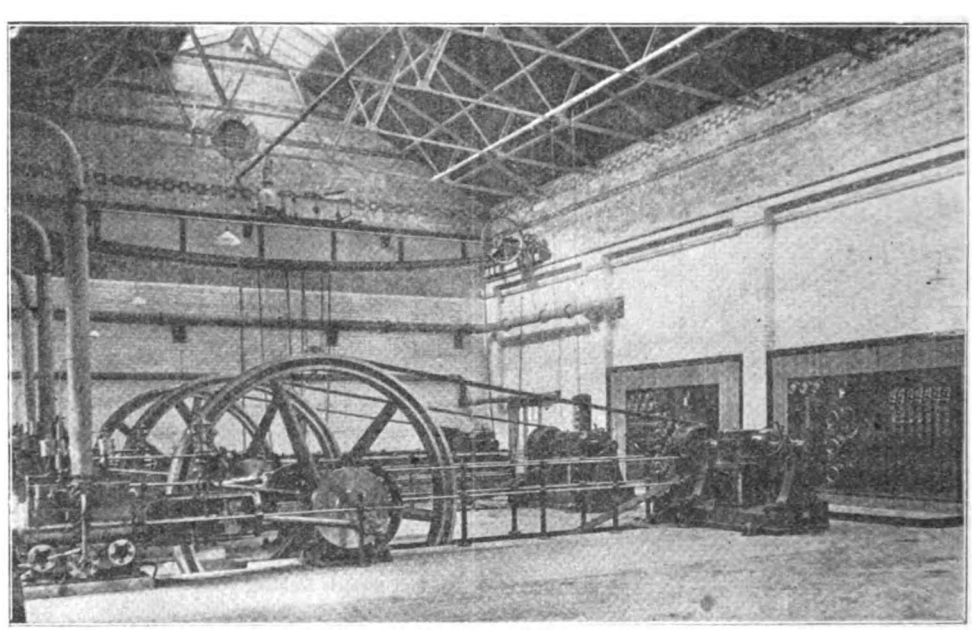

FIG. 3.—View of the Engine-room at Stafford.

It has been suggested that gas-engines should be adopted. I have not the least doubt that a perfectly satisfactory result could be attained with gas-engines. I should, however, prefer steam for two reasons—firstly, if gas-engines be used it is necessary to increase the number of accumulators employed, in order to secure that steadiness of light which is essential; accumulators, of course, are costly instruments, and it is not desirable to increase

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their numbers beyond what is really necessary. Secondly. on anything but a small scale steam is cheaper than gas, I consider it is absolutely necessary for the Corporation to will be speedily required, I should advise you to go to the Local Government Board for permission to borrow a larger sum."

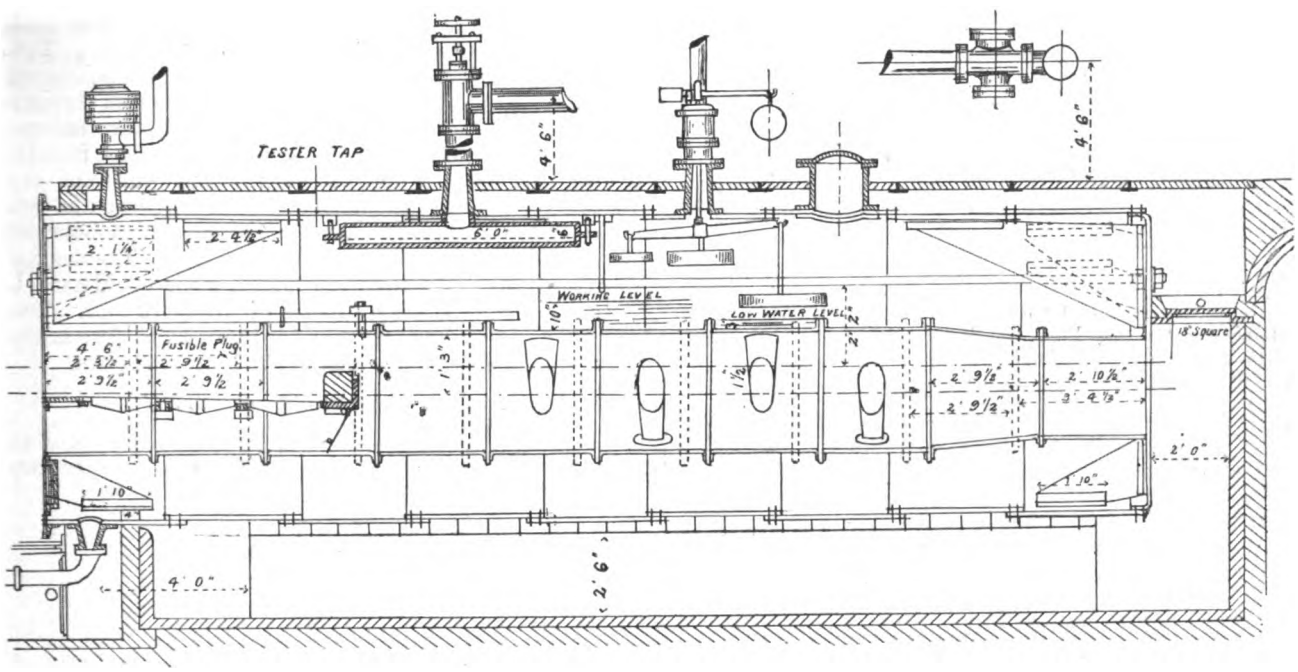
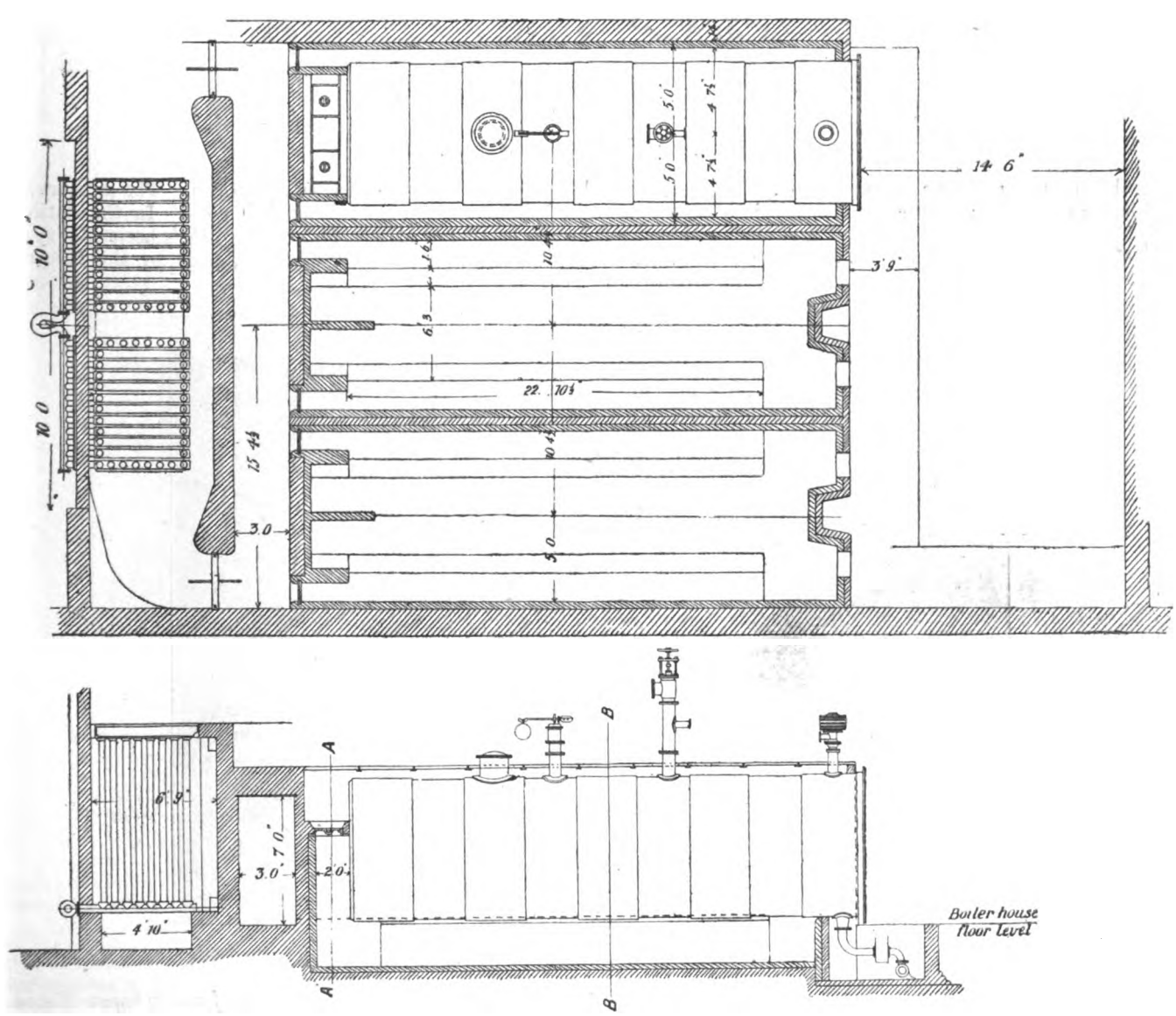


FIG. 4.—Detailed Section of the Lancashire Boilers.



FIGS. 5 AND 6.—Details of the Boiler Seatings.

incur an expenditure of £12,000. In this estimate there is an adequate allowance for contingencies, but meters are not included. As, however, I think that further extensions

Dr. Hopkinson's estimate included all apparatus required for lighting simultaneously 5,000 8-c.p. lamps, and he gave figures to prove that the station would be financially suc-

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cessful. It was decided to apply to the Local Government Board for permission to borrow £20,000, and, after an enquiry being held in December, 1893, the loan was sanctioned. Specifications were accordingly prepared and tenders invited, with a result that the following contracts were entered into for the supply of materials, etc.:

Foundations, etc., the Corporation	£1,837
Boilers, including boiler-feed pumps, economisers, and steam-pipes, Hick, Hargreaves, and Co., Limited	2,198
Engines, including steam-pipes in engine-house and pumps for condensing, Marshall, Sons, and Co., Limited	2,420
Dynamos, Electric Construction Corporation	1,151
Switchboards, Electric Construction Corporation	505
Mains, Siemens Bros. and Co., Limited	1,290
Traveller, T. Smith, Rodley	185
Buildings, H. Lovatt, Wolverhampton	3,030
Ironwork for roof, Rubery and Co.	197
Water-softener, Maignen Filter Company	220
Accumulators, Chloride Electrical Storage Syndicate	882
Exhaust-pipes, W. Bagnall and Co.	75
Overhead tank for condensing purposes, C. and W. Walker	117

Buildings.

The whole of the designs for the buildings were prepared by Mr. J. F. Bell, and that gentleman is to be congratulated on the general appearance of the station. The site chosen is in the east corner of the land attached to the Corporation gasworks, where there is ample space for extensions. The present buildings extend over an area of 70ft. by 130ft., and consist of a spacious and well-lighted engine-house, boiler-house, accumulator-room, and offices. The buildings are of red brick, with stone and blue-brick facings, the engine-room being lined with white glazed bricks. A dado of coloured glazed brick forms a pleasing relief, and adds to the general appearance of the room. The front elevation of the building is shown in Fig. 1, while Fig. 2 shows some details of the roofs, which were designed by the engineer. The construction, as will be seen, employs rectangular sections throughout, and combines economy with strength. The foundations were not easily obtained, as there is a good depth of peaty subsoil under the building. This necessitated a liberal use of piling. Piles of pitch-pine are employed, of about 40ft. length. These are driven through into the gravel and then braced together with cross-timbers. On these a 3ft. bed of concrete is placed to form a foundation for the footings of the walls. The whole of the foundations for the machinery in the engine-room are supported on piles, and there is no connection between these foundations and those for the building. The engine-room is spanned by a travelling crane, made by Messrs. I. Smith and Co., of Rodley, capable of lifting 12 tons. The chimney is of circular section, and is 135ft. high. The inside diameter at the top is 6ft., and at the bottom 7ft. 3in.

General Conditions of Supply.

The station is designed to supply on the low tension three-wire distribution system, with five low-pressure feeders connected to the outside mains. The pressure of supply to the consumer is at 100 volts. In the station, three engines of Messrs. Marshall and Co.'s horizontal type drive three direct-current dynamos, made by the Electric Construction Corporation, by means of cotton ropes. These are each capable of giving 66 kilowatts at a pressure of 220 volts. Fig. 3 gives a general view of the engine room. The dynamos supply by means of feeders the two outside wires of the three-wire network, and the balancing current is provided by one or other of two sets of Chloride accumu-

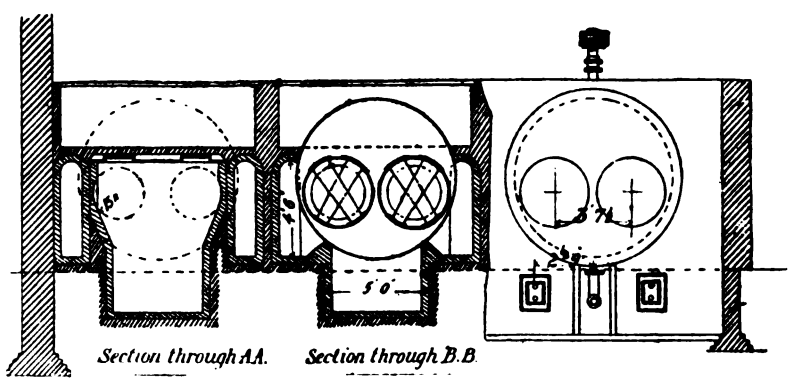

Fig. 7.—Transverse Sections of Boilers.

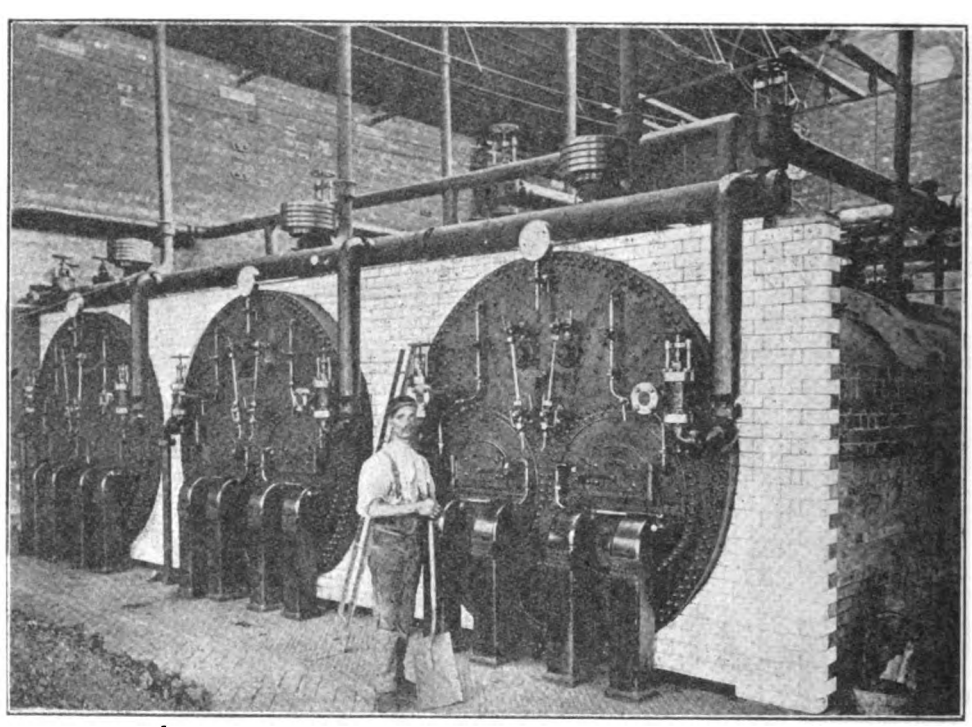

Fig. 8.—View of Boilers, showing Meldrum's Blowers.

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lators. The accumulators are also intended to materially assist the generating plant at heavy loads and to supply the whole of the light load periods, when the demand is not sufficient to warrant the running of an engine. At such times of light load the boilers will be used to supply steam to the gasworks, and hence will be always under steam should sudden demand arise. In return for this advantage of using the steam, the gas department will supply to the electricity works all their refuse coke and coke screening free of charge. There is also a proposed arrangement for

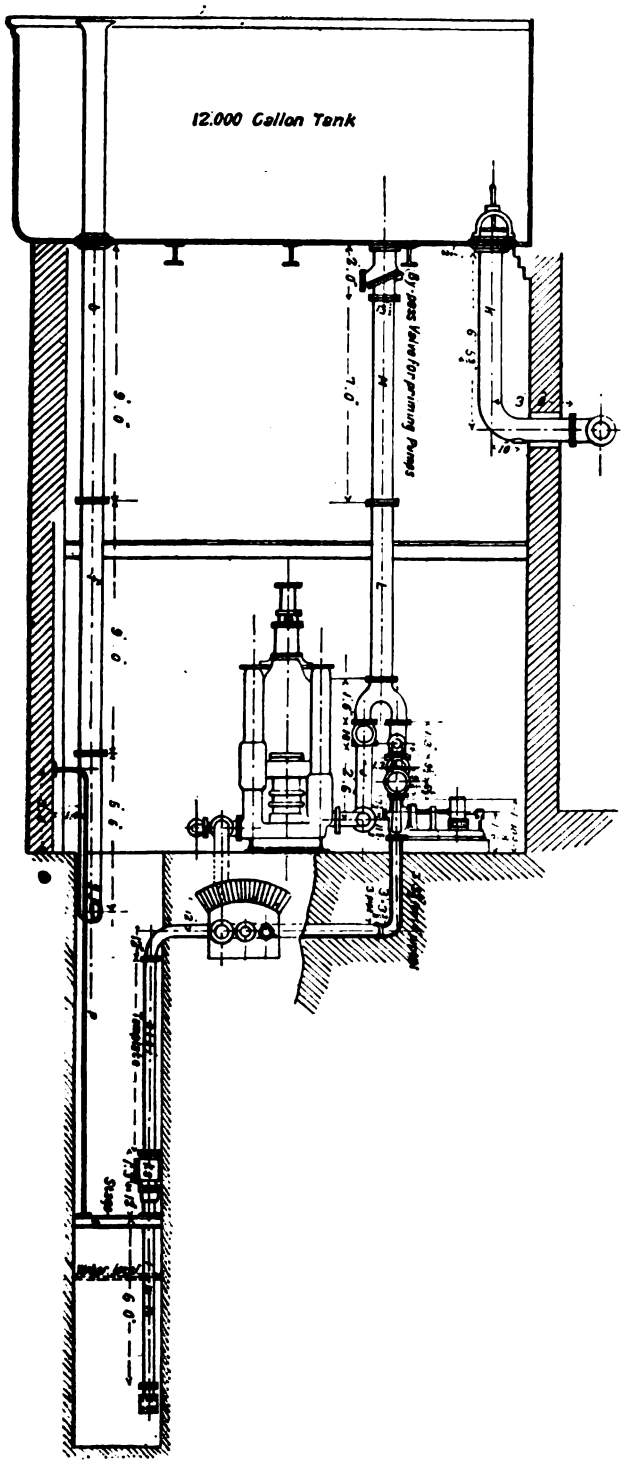

FIG. 9.—Sectional Elevation of the Pump-house.

cash payment as well, which would practically nullify the usual fuel charges in the electric works.

STEAM GENERATING PLANT.

The present boiler plant consists of three Lancashire boilers, made by Messrs. Hick, Hargreaves, and Co., of Bolton. The specification for these boilers was prepared by Mr. J. F. Bell, and submitted to Dr. J. Hopkinson for approval. The boilers have the following leading dimensions: Length, 28ft.; diameter, 7ft. 6in. The two flues have an internal diameter of 3ft. at the furnace end, and taper down to 2ft. 6in. at the other end, as shown in Fig. 4. Thickness of plates: cylindrical shell, $\frac{5}{8}$in.; flue tubes, except end rings, $\frac{1}{2}$in.; end rings of flue tubes, $\frac{9}{16}$in.; end plates, $\frac{5}{8}$in.; outer cover strips, $\frac{5}{8}$in.; inner cover strips, $\frac{7}{16}$in.; gusset plate, $\frac{5}{8}$in. Angles: front end of shell, $4\frac{3}{4}$in. by $4\frac{3}{4}$in. by $\frac{11}{16}$in.; gussets, $3\frac{1}{4}$in. by $3\frac{1}{4}$in. by $\frac{9}{16}$in.; $\frac{13}{16}$in. rivets are used throughout the shell.

All the plates, angles, and rivets are of the best Siemens-Martin steel, tested under the supervision of the National Boiler Insurance Company. Two $2\frac{1}{2}$in. diameter longitudinal stays are placed in each boiler, and have ends enlarged and screwed $2\frac{1}{2}$in. diameter. Four conical welded cross-tubes of $\frac{3}{8}$in. steel are fitted in each of the flue tubes, the cross-tubes being about $5\frac{1}{2}$in. diameter at the bottom end. Figs. 5, 6, and 7 show details of these three boilers and their settings, and Fig. 8 is a view taken from one corner of the firing space of the boiler-room. The following boiler mountings are attached to each boiler, and are designed for a working pressure of 125lb. per square inch: a Turnbull patent dead-weight safety-valve, $2\frac{1}{2}$in. diameter, having suitable waste-pipes to discharge the steam outside the boiler-house; a Hopkinson patent "Duad" high-steam and low-water safety-valve (1890 patent); a Hopkinson patent "Triad" junction-valve, with brass valve and seating, fitted with regulating screw, spindle, and handwheel (the above valve is 6in. internal diameter); a $2\frac{1}{2}$in. Hopkinson patent

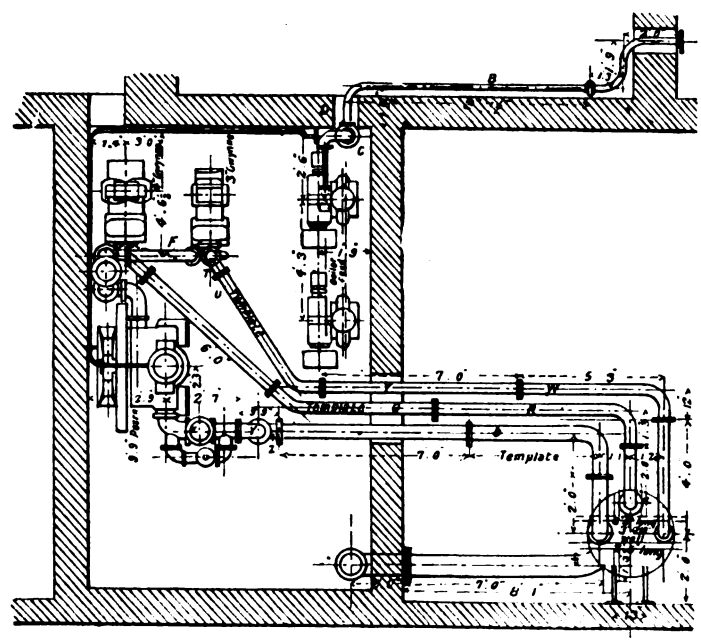

FIG. 10.—Plan of Pump-house.

accessible check-feed valve, combined with back-pressure arrangements and regulating screw, and so arranged at the front end as to be within easy reach of the attendant also; two gauge glasses of the patent safety type by the above maker, a steam-pressure gauge, and a blow-out cock.

The furnaces of these boilers are of the "Meldrum" forced-draught type, which are now being extensively adopted to enable any kind of cheap fuel, such as coke breeze, common slack coal, or anthracite coal, to be used, which is a great advantage. A further important advantage is that when a sudden demand arises from any cause, such as fog or thunderstorms or the like, which under ordinary conditions is most difficult to supply, with this system the boilers may be instantly forced and the evaporation increased without any trouble. Messrs. Meldrum Bros. have recently introduced an improvement, which has been adopted at Stafford, by which what we should consider the chief drawback to the adoption of this system at electric supply stations has been overcome, and that is the noise occasioned by the inrush of atmospheric air and steam through the blowers. This has been entirely overcome by means of an ingenious contrivance which introduces resistance in the air-admission passage, and in this way silences the blower. The needful air supply is obtained through special tubes, which are the subject of a protecting patent, and which pass through the foot-plates. Fig. 8 shows the silencing apparatus in position. We understand that the boilers at the Islington electric supply

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station, which are to be supplied with the "Meldrum" furnaces, are also to be similarly fitted with this special improvement.

The furnace bars are placed specially near together to enable the coke breeze from the gasworks to be used, and then occasionally, when heavy demand arises, coal will be added to increase the output of steam.

from the sudden and dangerous strains to which flywheel pumps are subject. They work at a moderate speed, and by means of special valve gear the pistons are slowed down towards the end of the stroke, and the valves have time to settle into their seats. This also prevents any jar or shock, as there is no sudden reversal of the piston. Another feature of the design is the large water area through the

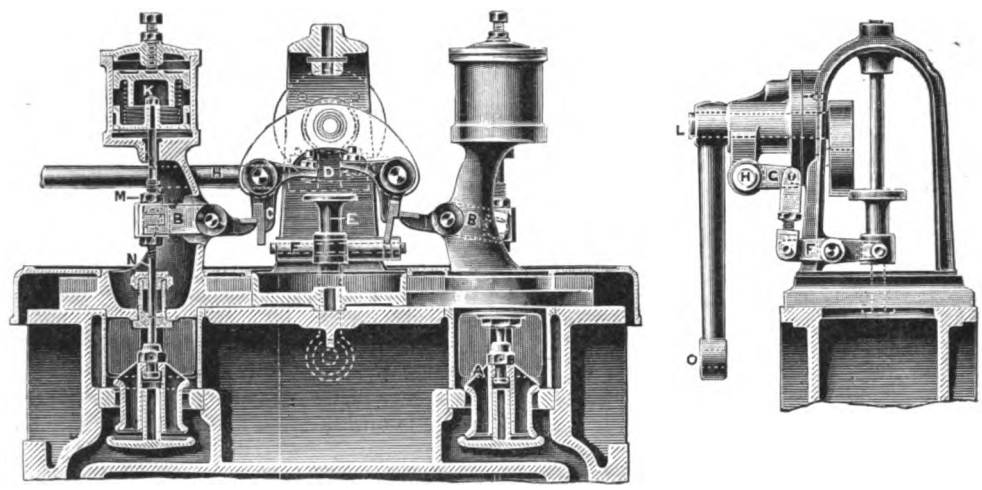

FIG. 11.—Details of the Proell Valve Gear.

The economiser is on Messrs. Green's new principle, and is constructed from improved strengthened patterns, suitable in every detail for a working pressure of 125lb. to the square inch. The whole is of the best material, approved construction, and workmanship, and tested to a pressure of 350lb. per square inch before leaving Messrs. Green's works. The economiser is arranged in two groups, with expansion

valves, which are of a special type for high-pressure boiler feeding. There is no dead centre, and the pumps will start at any part of the stroke. The length of the stroke and the requisite amount of clearance can be adjusted in a few seconds. The pumps are fitted with special buckets, and are compact and well finished in every way.

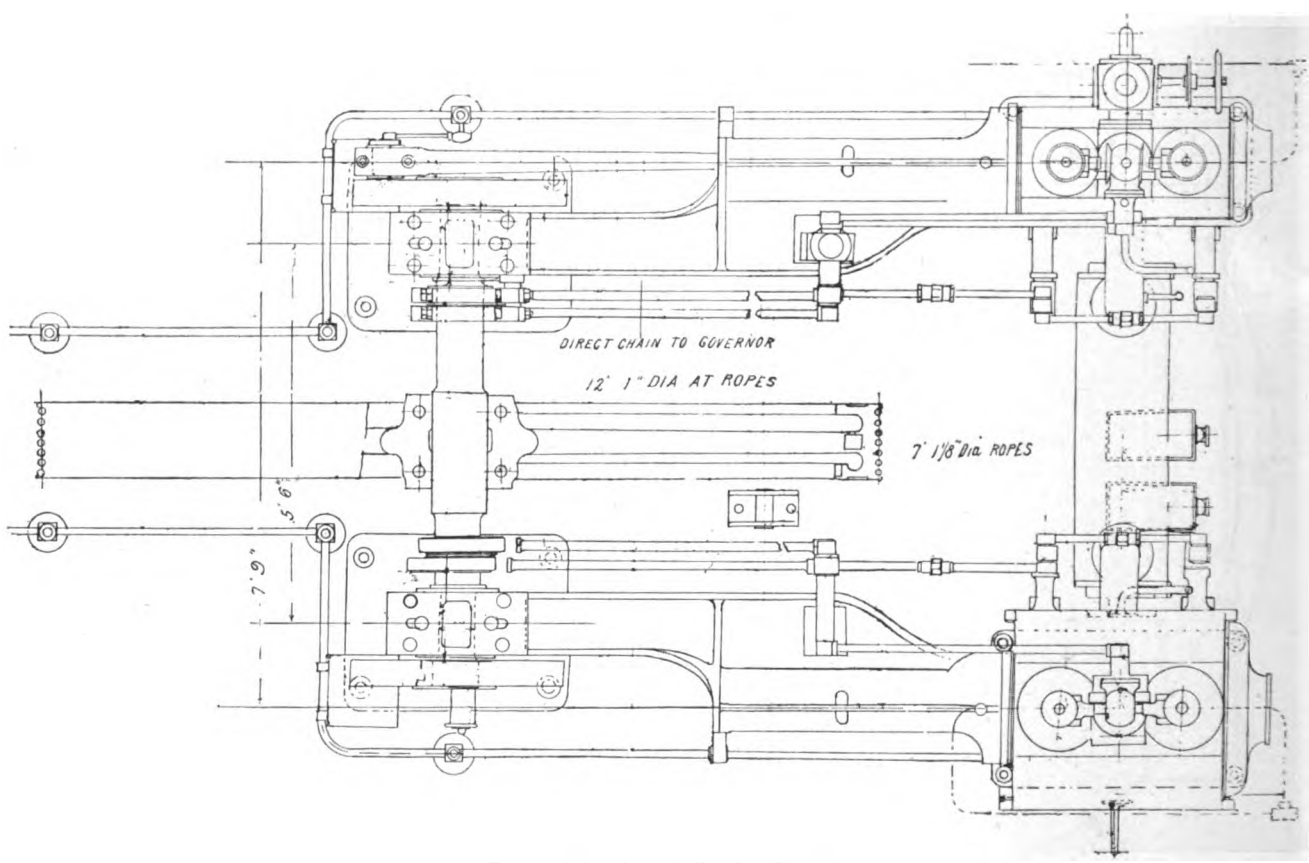

FIG. 12.—Plan of Marshall 90-h.p. Engine.

elbows top and bottom, and is provided with a 3½in.-cylinder engine for driving the scraping gear. The economiser consists of 128 tubes $4\frac{9}{16}$in. diameter and 9ft. long.

FEED-PUMPS.

The boilers are fed with two of Weir's patent feed-pumps, 6in. by 15in. stroke, made by Messrs. G. and J. Weir, Limited, Holm Foundry, Cathcart. These pumps are of the direct-acting type, and are consequently free

An alternative method of feeding is provided by the use of three Giffard injectors, supplied by the Patent Exhaust Steam Injector Company. These are made of gunmetal throughout and are cross-connected, so that any injector can be made to supply any boiler. The feed-pipes also are so arranged that the feed water may either be supplied direct or through the economisers. The details of the machinery in the pump-house will be gathered from Figs. 9 and 10.

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Steam and Exhaust Pipes.

The usual method of arranging the main steam-pipe in a ring has been departed from in this station, and the engineer endeavoured to reduce the chance of accidents to a minimum by making all the parts of ample section. The main steam-pipe is of Siemens-Martin steel, 10in. diameter, with steel flanges screwed on, faced and bolted. It is carried on cast-iron brackets on rollers, so that any expansion does not produce strains at the points of support. The branch connections to the boilers and engines are of the same type, and are 6in. diameter inside. The main exhaust-pipe is of cast iron, 12in. diameter inside. The water-main which supplies the condensers is also of cast iron, and is 18in. diameter, the branch pipes being 3½in. diameter. The discharge-pipe carrying away the water and condensed steam from the Korting condensers is 12in. diameter, leading into a 15in. sewer.

The condensing water is obtained from the river, and is pumped up into the tank (shown in Fig. 9) by two electric pumps, by Gwynne and Co., and a steam pump, by Pearn and Co. Three Korting ejector condensers are provided for each engine.

The Engines.

There are three engines of the horizontal, coupled, compound type by Marshall, Sons, and Co., each with high-pressure cylinder 11in. diameter, low-pressure cylinder 19in. diameter, both 26in. stroke. The cylinders are steam-jacketed, the inner barrel being cast separately of a special hard mixture of iron, and tightly forced into the main casting of the cylinder. The clearances are carefully worked out, and the inside faces of the covers and both sides of the pistons are turned and polished to prevent initial condensation. The governors are Dr. Pröell's patent, with two valve-releasing gear and Corliss exhaust-valves, and the governors are chain-driven direct from the crank-shaft.

(Continued on page 424.)

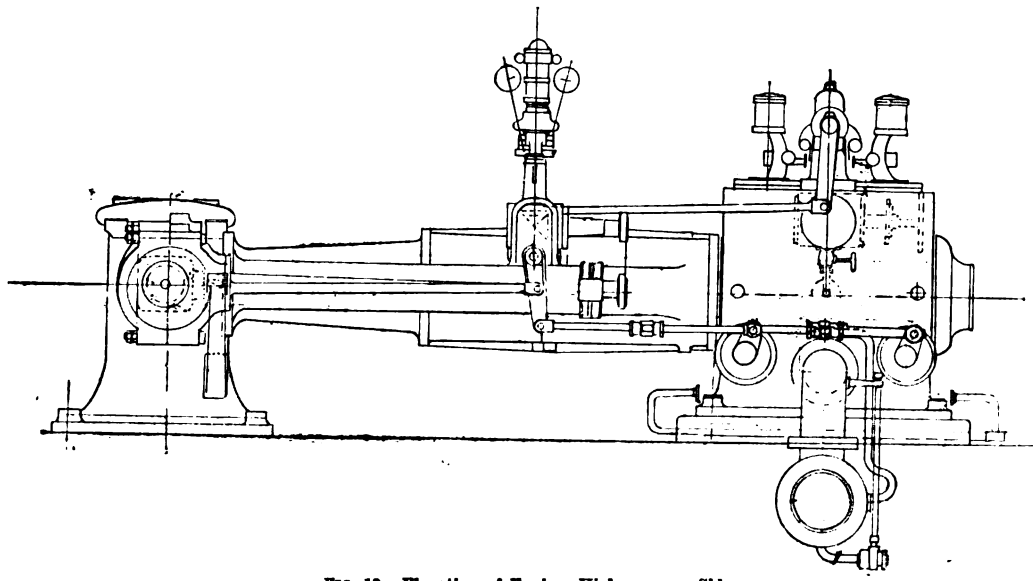

Fig. 13.—Elevation of Engine, High-pressure Side.

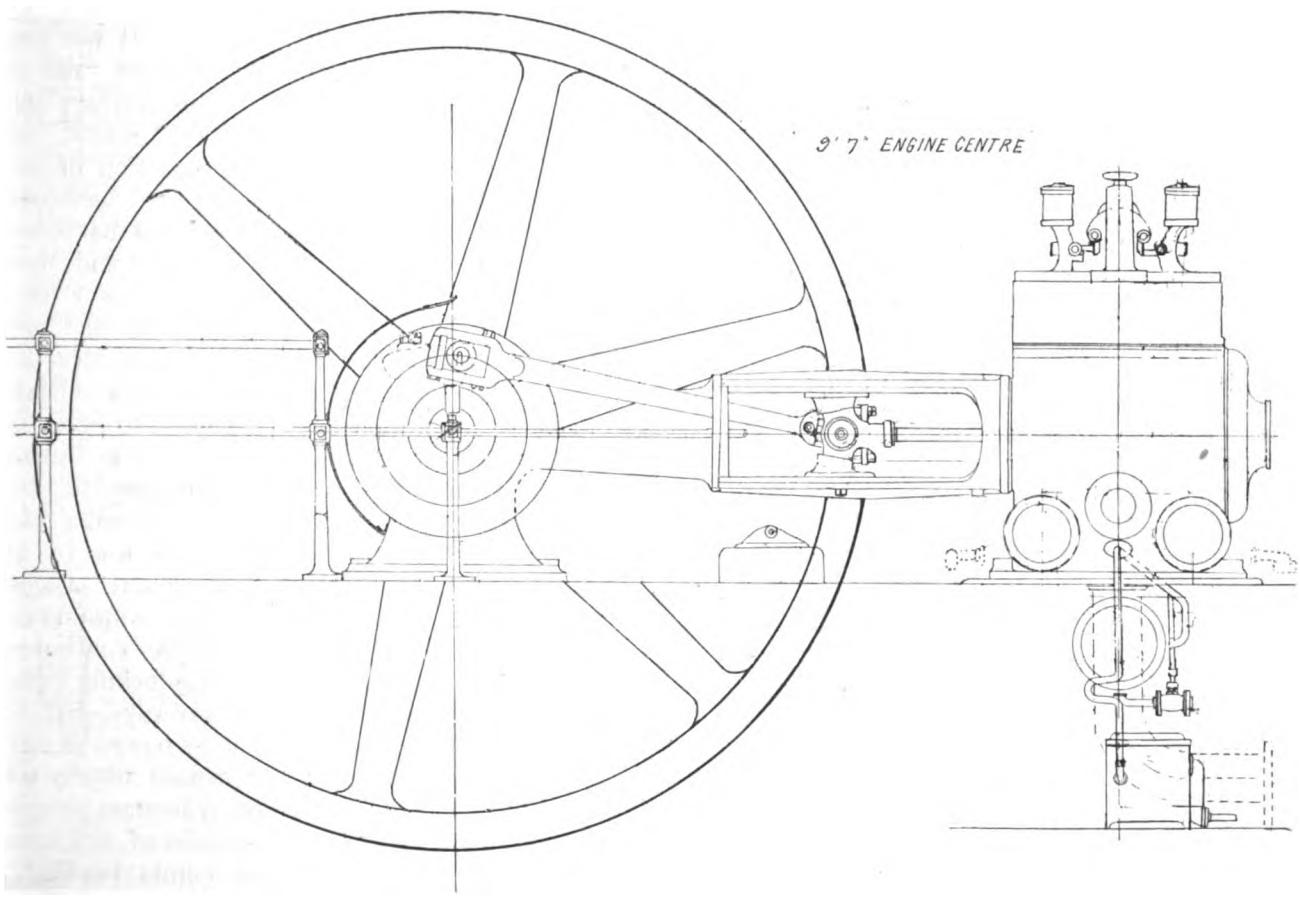

Fig. 14.—Elevation of Engine, Low-pressure Side.

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"AN EXTRAORDINARY CASE."

This was an exclamation of Prof. FitzGerald's as regards the fatal accident on the Portrush electric railway in the beginning of August. A summary of the evidence at the Board of Trade enquiry held by Major Cardew was given by us in our last issue, and it is in the evidence that Prof. FitzGerald's exclamation will be found. We cannot comment upon this evidence till the report of Major Cardew is made public; but there are incidental questions relating to all enquiries of this kind that may well be mentioned. In the first place, accidents, fatal or otherwise, cannot be wholly avoided when there is moving machinery. No matter what precautions are taken, the unforeseen will arise and an accident will happen. This conclusion ought not to prevent us taking all possible precautions to prevent accidents, and no matter whether we are dealing with an electric or any other railway, "prevention is better than cure." One great difficulty in the way of prevention is that we do not always know what to prevent. The state of our knowledge at the present day would prevent a second Portrush electric tramway being built, but the state of our knowledge now is not what it was ten or twelve years ago, nor what it will be ten or twelve years hence. No doubt the work of to-day will twelve years hence be reckoned defective, even as we look upon the work of twelve years ago as defective. Are we to stop the work of to-day because of the further information the future will bring forth? The Portrush railway was built years ago. It was compulsorily a cheap line, otherwise there was no prospect of return for outlay. The ordinary engineering mind would agree to the formula, take every known precaution for the prevention of accidents at the time of constructing the machinery. There seems to be no possible objection to that course. There is, however, a much greater and much weightier question behind. Is a railway or a tramway, which has complied with all the rules and regulations in force at the time of construction, to be compelled to carry out every change indicated by advance in knowledge? It is usual to erect the best machine known at the moment and to continue to use that machine as long as possible, even though progress is made in that particular class of machinery and better machines are in the market before the original is worn out. Capital can hardly be limited if change is continuous—and in all directions change is continuous. Facing points are not obsolete, interlocking signals are not everywhere found on railways, but the old designs are not all replaced by newer designs. Our point, in fact, is this: you cannot utterly condemn something that is convenient because progress has rendered it somewhat old-fashioned and knowledge has shown it has weak points tending to accidents. We must not be taken to say the Portrush tramway is dangerous. Like Prof. FitzGerald, we say the fatal accident presents "an extraordinary case." Expert evidence here, as in so many other cases, must seem very divergent to the general reader, but the fact is—and every expert fully understands it is so—the conditions surrounding a fatal acci-

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dent are so complex that it is difficult to say which is the predominant feature leading to the exact result. In this particular case witness after witness came forward to say that boys and girls, workmen and visitors, are often taking shocks, and up to the accident under consideration with no other result than inconvenience. The state of the body, the state of the rails, the state of the earth, the state of the atmosphere, the state of the machinery, the number of cars suddenly put on or off the line, these and many other things have to be considered. A particular combination of circumstances may lead to an accident, but in many cases the combination is extraordinary—could hardly, or not at all, be obtained at will. The expert evidence at the enquiry was of two kinds: on the one hand, that nine animals have been killed; on the other, that people come from a distance to take shocks to try and cure rheumatism.

The extreme pressure upon our space caused by the descriptions of the various central stations just completed, renders it impossible to discuss the interesting material which has appeared in the *Lancet* on death by electric shock. Dr. Shettle, in a long letter which appeared on September 14, rather supported the views of Dr. Bleile, of Ohio, that death was due to the action of the nervous system upon the arteries. Dr. Shettle explained his views, which are founded upon magnetic action, and an editorial appended to his letter traversed the views expressed therein. On September 21 the *Lancet* dealt editorially with the subject, and on September 28 Dr. Shettle replied. We hope to give the whole of this correspondence at an early date, but meanwhile we desire to call attention to the fact that the electrolytic action of the current upon the fluids of the body is by this class of experts absolutely ignored. This again goes to prove, from another point of view, how extraordinary everything connected with fatal electric accidents must appear to the non-technical reader. Of course the coroner and his jury, or the president of an enquiry, have to deal with the fact of death, and have nothing to do with physiological effects; but the time may come when a real knowledge of the latter will simplify all enquiries in this direction.

THE FALLS OF FOYERS.

The following correspondence has taken place between the Duke of Westminster and the British Aluminium Company, Limited, 9, Victoria-street, Westminster, respecting the Falls of Foyers:

"9, Victoria-street, Westminster, S.W., September 19.

"To his Grace the Duke of Westminster, K.G.,

"Grosvenor House, W.

"My Lord Duke,—I am instructed by the directors of this company to write in reference to the letter, dated July 31 last, signed by your grace, and published in the *Times* and other newspapers, which comments upon their proposed works in Scotland.

"The company, considering that they alone had the right to deal with their own property, have hitherto refrained from entering into any controversy in the public Press concerning the works they propose to erect at Foyers; but the great importance that has been given to your grace's letter by its frequent republication and comments in the Press makes it necessary, in the opinion of those who advise the company, that the incorrect statements made therein, founded, no doubt, on improper information given to your grace, should now be publicly corrected. The directors feel sure that it will only be necessary to show to your grace wherein these statements are wrong, to have them corrected in the same public manner as they have been made, and that they are not mistaken in supposing your grace will, after reading this letter, cause these corrections to be made.

"Your grace states that, in connection with the aluminium works which are about to be started at Foyers, great spoil heaps will be created. As a matter of fact, the process to be carried out at Foyers consists only of the electrolytic decomposition of the oxide of aluminium, and consequently there will be no solid or liquid residuum, and no heaps formed which will spoil the beauty of the place. The oxide of aluminium is obtained from the company's mines in Ulster in the form of bauxite, which which is afterwards treated at the company's works at Larne, so as to free it from its impurities.

"Secondly, it is stated in the same letter that the factory there will emit hydrofluoric acid gas, which will be most destructive to the vegetation in the neighbourhood. If this were the case, the only party concerned would be the company, as proprietors of the land for several miles round the site of the factory. In reality, however, no such destructive effect will occur, as your grace's informants could have easily found out by procuring a report as to the state of the vegetation in the neighbourhood of the Continental factories at Schaffhausen and Froges, or by reading the official report on this matter published by the Swiss Government authorities.

"There remains an allegation in your grace's letter to be answered—viz., that the agent of this company has stated that 'the Falls will not be injured, only there will be no water in them.' This statement is untrue, and was not made by any person in the employ of the company.

"The company has never contemplated taking all the water passing over the Falls, or interfering with their natural structure, and such water as the company do not use will pass over the Falls as at present, but should the company's proposals for the storage of the water during flood times not be allowed, the company may reluctantly be compelled to utilise in times of scarcity the whole of the flow.

"The works carried out at Foyers will be very beneficial to the whole district, and consequently the company have received the cordial support of the local authorities and inhabitants. Those who are well acquainted with the neighbourhood recognise that the submergence of the boggy land between Lochs Garth and Farraline, and the creation of one grand loch, will be a distinct improvement to the scenery.

"Your grace will therefore see that the attempt to influence the decision of the County Council is calculated, if successful, to defeat the object your grace has in view—viz., the securing the amenities of the place to those visitors who desire to view the beauties of the Highlands.

"The directors have fully considered the scheme for the production of this metal, and have adopted the only method open to them to secure to this country the benefit resulting from this important industry.

"The directors feel convinced that your grace will, without delay, correct publicly the misleading statements contained in the above-mentioned letter, which are undoubtedly due to misrepresentations made to your grace by persons not possessed of adequate information.—I beg to remain, my Lord Duke, your obedient servant,

"For the British Aluminium Company, Limited.

"CHARLES F. JONES, secretary."

"September 30, 1895.

"Duke of Westminster, Eaton Hall, Chester.

"We wrote your grace on 19th inst., under registered cover, asking for public contradiction of misleading statements made in your letter concerning our business. So far we have received no reply, and, besides, to-day a letter is published by someone connected with your grace in this matter making baseless insinuations against honourable people who have acted straightforwardly and for the good of their district. Unless a thorough retractation is published before next Thursday, October 3, we shall feel compelled to send the whole of the correspondence to the public Press.

"BRITISH ALUMINIUM COMPANY, 9, Victoria-street, S.W."

"Eaton, Chester, Oct. 3, 1895.

"Dear Sir,—I am directed by the Duke of Westminster to acknowledge the receipt of your letter of September 19 with regard to the works that it is proposed to erect at Foyers.

"His grace is afraid that he cannot correct the alleged misstatements in his letter of July 31, and would suggest that the directors of the British Aluminium Company should, if they see fit, publish your letter of September 17 as a reply to his grace.

"I regret that there should have been a delay in replying to your letter, which was sent to me by his grace at a time when I was travelling in Scotland, and which I inadvertently mislaid.

"With many apologies for the consequent apparent want of courtesy, I remain, yours faithfully, "ARTHUR LAWLEY.

"The Secretary, British Aluminium Company."

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STAFFORD ELECTRICITY WORKS.

(Concluded from page 421.)

The illustration (Fig. 11) represents a section of a cylinder fitted with Pröell's patent two-valve gear. This gear consists of two equilibrium admission valves, A, one to each end of the cylinder. These are alternately lifted by means of the valve spindle in connection with the principal trip levers, B. These trip levers are depressed by means of the L levers, C, which are connected on opposite ends of the rocking lever worked from the eccentric. The ends, D, of the L levers, projecting towards the centre, are brought into contact at each stroke with the trip pad, E. This trip pad is connected with the governor through the medium of the levers F and G and the shaft, H; and the height of this trip pad determines the moment of cut-off of the steam, for as soon as the end, D, of the L lever reaches the trip pad, any further movement of the rocking lever disengages the L lever from the trip lever, B, and the valve immediately closes. The closing speed of the valve can be very readily regulated by means of the spring box, K, so that although it closes the valve very rapidly, it does it very quietly, thus preventing any undue wear of the valves or faces. All the working parts of this gear are case-hardened, and the cutting-off edges are made of tool steel, hardened. The governor controlling this gear is of a very powerful and sensitive type, and has sufficient range to regulate the cut-off at any point up to five-eighths of the stroke. It can be fitted with a special adjusting arrangement, so that the speed of the engine may be varied 5 per cent. either way whilst the engine is running: this is a point of considerable importance for many classes of work, and enables the speed of the engine to be most accurately adjusted.

The crankshaft and bearings are of extra strength; all the wearing parts are amply large. Brass bushes and neck rings are provided for all rods, with patent metallic packing for the stuffing-boxes, and complete and efficient lubrication is everywhere provided. The flywheels are grooved for rope-driving, and fitted with barring gear. Pillars with hand-rails are placed round the discs, connecting-rods, and flywheels, and the engines throughout are fitted up in the first-class style for which this firm is renowned. With each engine is provided a Korting condenser with non-return valve, but the engines are so arranged that they may be worked either condensing or non-condensing. The condensers are fed by an overhead tank, which is supplied with water from the river by two electromotor

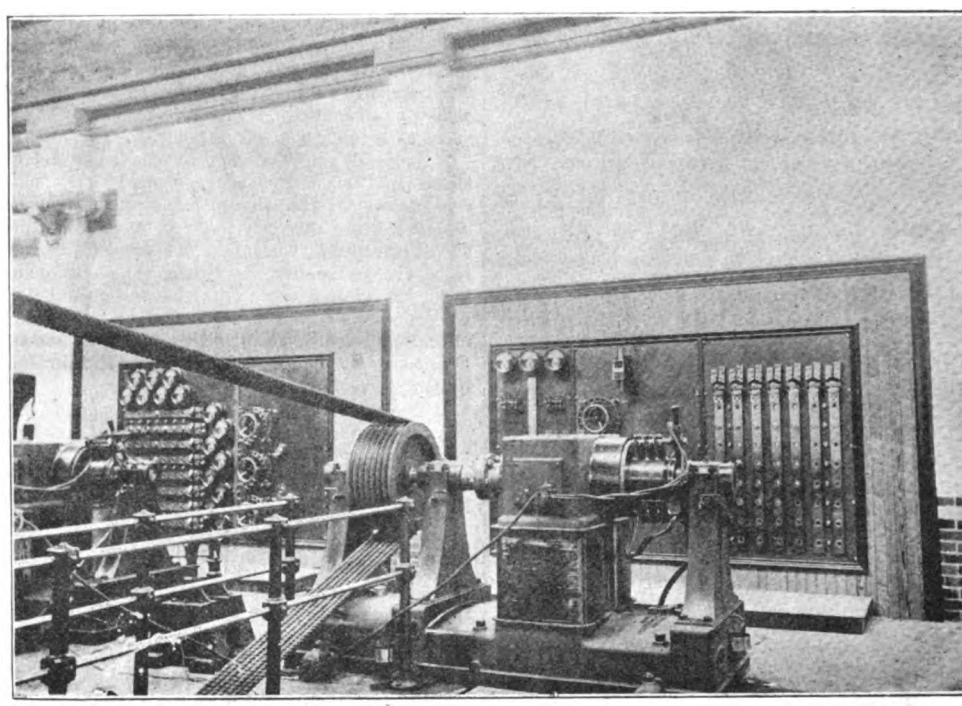

FIG. 15.—View of the E.C.C. 66-K.W. Dynamos and Switchboards.

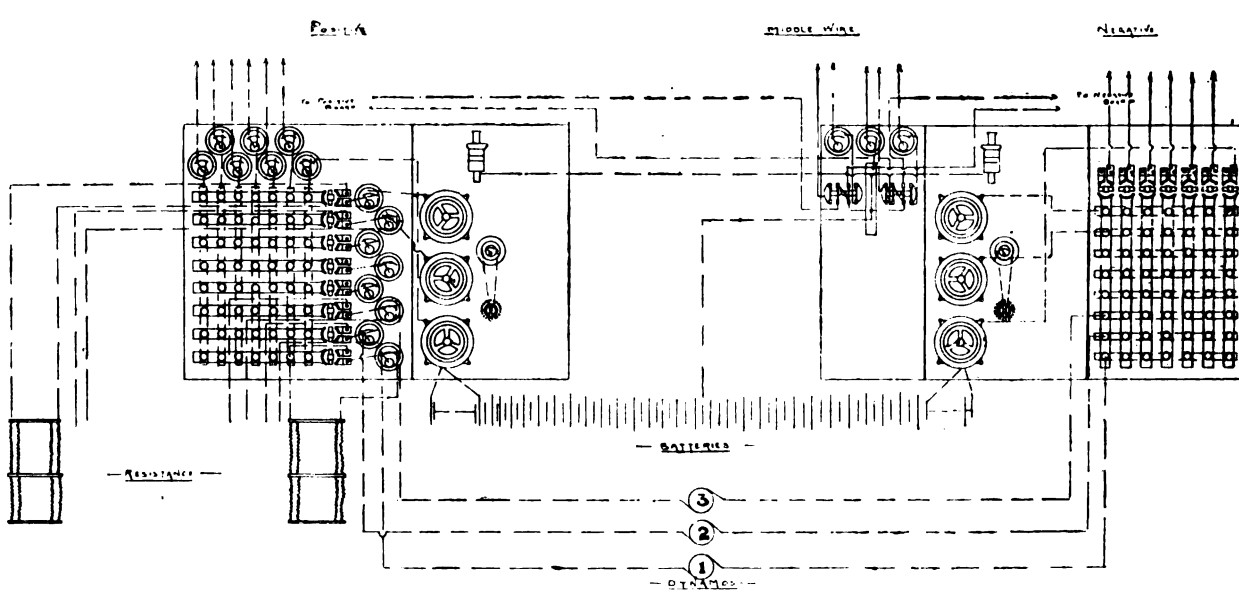

FIG. 16.—Stafford Switchboards and Connections.

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pumps and one tandem compound plunger steam-pump of the Cameron type; this latter pump is also condensing in the same manner as the engines.

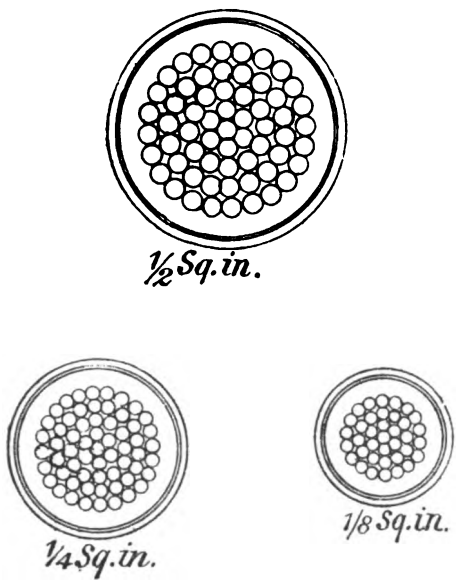

FIG. 17.—Full-size Sections of Siemens Cables.

Each engine is capable of delivering 90 b.h.p. to the ropes which drive the dynamos. The steam-consumption dynamo machine fully loaded so as to receive about 90 h.p., and will then be indicated from time to time and the mean value taken. The engine will afterwards be run with its dynamo machine light, and the engine will be again indicated. The difference between the two indicated horse-powers shall be taken as the net power of the engine. The steam supplied during four hours or thereabouts to the engine and jackets will be determined. If the water used is less than 21lb. per net horse-power per hour, the Corporation will pay to the contractor in respect of each engine at the rate of £20 for every pound by which this water is less than 21lb. If the water used is more than 21lb., a sum, at the rate of £20 for every pound by which the water is more than 21lb., is to be deducted from any sum or sums due or which may become due to the contractor in respect of each engine.

The general view of the engines in position is shown in Fig. 3, while Figs. 12, 13, and 14 give the details of construction.

DYNAMOS.

These are driven by the engines by means of seven 1⅛in. ropes. The three dynamos were manufactured by the Electric Construction Corporation, and are shunt wound. There are three E. C. C. shunt-wound dynamos, Fig. 15, each giving an output of 300 amperes, 220 volts, running at a speed of 600 revolutions per minute. Each machine is fitted with three bearings, and the armature is driven by a rope pulley. The top half of the magnet is arranged to lift off, so that the armature may be removed without upsetting the bearings. When completed, the following tests

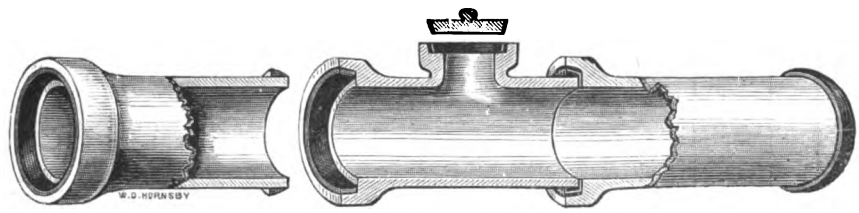

FIG. 18.—Details of Stanford's Patent Joint.

trials in accordance with the specification have yet to be made, but Marshall, Sons, and Co. are confident that these designs will win premiums. The conditions of trial and bonuses will be as follow: The engine will be run with its dynamo machine fully loaded so as to receive about 90 h.p., and will then be indicated from time to time and the mean value taken. The engine will afterwards be run with its dynamo machine light, and the engine will be again indicated. The difference between the two indicated horse-powers shall be taken as the net power of the engine. The steam supplied during four hours or thereabouts to the engine and jackets will be determined. If the water used is less than 21lb. per net horse-power per hour, the Corporation will pay to the contractor in respect of each engine at the rate of £20 for every pound by which this water is less than 21lb. If the water used is more than 21lb., a sum, at the rate of £20 for every pound by which the water is more than 21lb., is to be deducted from any sum or sums due or which may become due to the contractor in respect of each engine.

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DYNAMOS.

These are driven by the engines by means of seven 1⅛in. ropes. The three dynamos were manufactured by the Electric Construction Corporation, and are shunt wound. There are three E. C. C. shunt-wound dynamos, Fig. 15, each giving an output of 300 amperes, 220 volts, running at a speed of 600 revolutions per minute. Each machine is fitted with three bearings, and the armature is driven by a rope pulley. The top half of the magnet is arranged to lift off, so that the armature may be removed without upsetting the bearings. When completed, the following tests were made of two of these machines by Dr. Hopkinson: Two machines selected were coupled together—the one providing current to drive the other as a motor, the latter the mechanical power to drive the former. The magnets

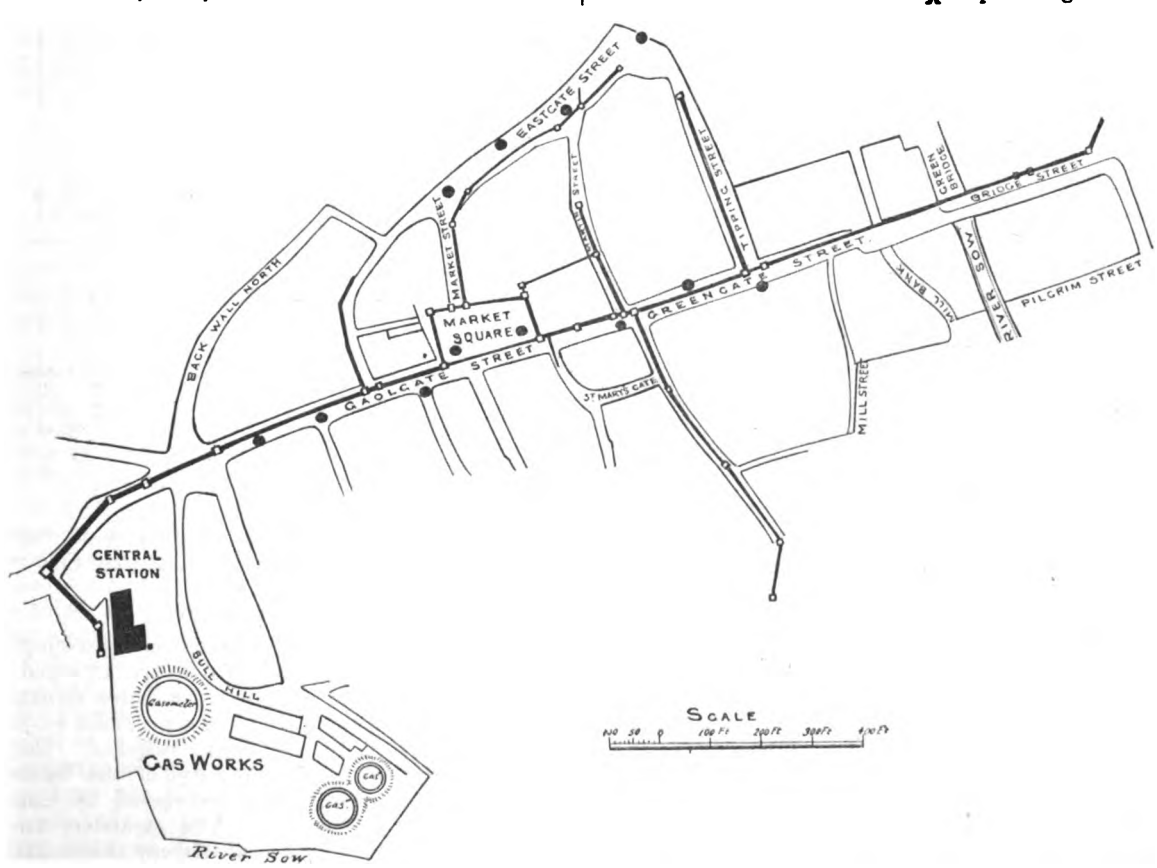

FIG. 19.—Plan of Mains now Laid at Stafford. • denotes Proposed Arc Lamps

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were separately excited with the appropriate currents. In series with the armatures of the two machines, a third machine was coupled to give the excess of potential required by the motor above that given by the generator. The various parts of the combination were so adjusted that the generator gave a current of not less than 300 amperes at 220 volts at a speed not greater than 600 revolutions. The whole combination was run under these conditions for six hours without sensible sparking, without excessive heating, and without developing any defect in either machine. During the last two hours of the run the following test of efficiency was made: The potential difference between the brushes of the motor and the current passing through the machines was measured. To the product of them was added the power in watts used in the magnets of the motor, the sum being the power supplied to the motor. The difference of the potential differences of the motor and generator was measured, and this subtracted from the potential of the motor gave the potential difference of the generator. From the product of this potential difference and the current passing was deducted the power in watts used in the magnets of the generator, and the difference gave the power of the generator. The ratio of the power of the generator to the power of the motor reckoned as a percentage is then the efficiency of the combination.

The guaranteed combined efficiency of the two machines was 84 per cent., and the Corporation offered £30 bonus for every 1 per cent. by which this combined efficiency was exceeded. On the trial referred to Dr. John Hopkinson obtained an efficiency of 88·1 per cent. for the combined set. Thus the total bonus of £122 was awarded to the makers. The average efficiency of each machine thus works out at 93·9 per cent.

Batteries.

The batteries consist of 112 Chloride cells. The cells are of the company's specially protected type, and contain 29 plates in each cell, mounted upon glass suspension plates, and fitted in wood boxes lead-lined. The special protection with which these cells are fitted is a speciality of the Chloride Company's, and consists in each positive plate being encased in a sheet of asbestos cloth, with separators between the positive and negative plates. Provision is made for the free circulation of the electrolyte, and the active material is at the same time held in position. The output of the battery varies with the rate of discharge as follows: It will give 294 amperes for three hours = 882 ampere-hours; or 182 amperes for six hours = 1,092 ampere-hours; or 140 amperes for nine hours = 1,260 ampere-hours; 112 amperes for 12 hours = 1,344 ampere-hours. Owing to the high capacity of the Chloride plates, the space occupied by the battery is claimed by the makers to be some 40 per cent. less than that required for other types.

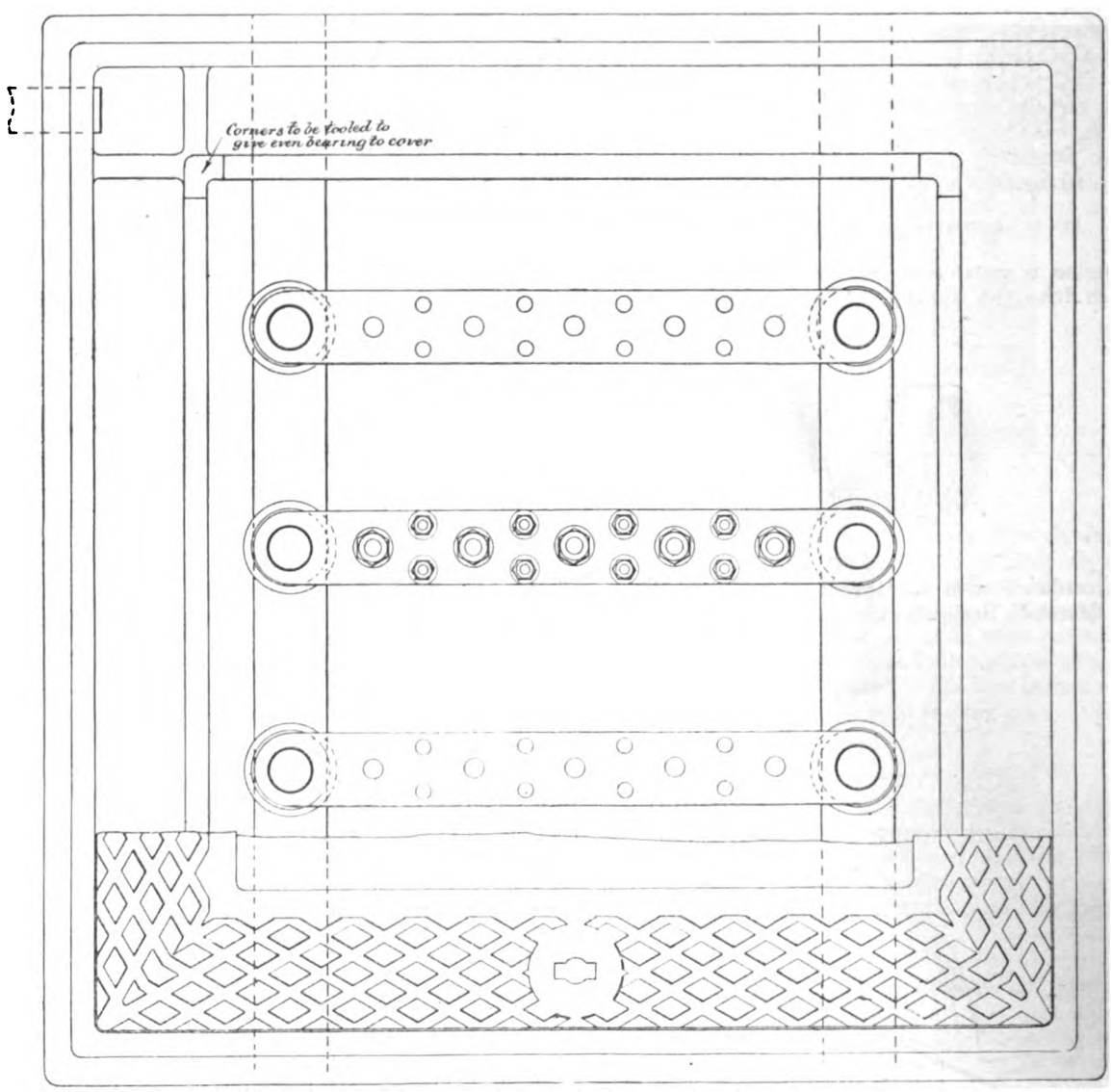

Fig. 20.—Plan of Distributing-box.

Switchboard.

The Electric Construction Corporation also supplied the main switchboards, Fig. 16, which are arranged on the three-wire system for coupling the three dynamos and accumulators on to any one of the six circuits by means of screw-plug connections and main switches. Regulating switches for the charge and discharge of the batteries are provided, the sparking being prevented by means of a resistance across each contact. The ammeters are of the well-known E. C. C. pattern, Kelvin electrostatic voltmeters being also provided. The boards are divided into five panels, supported on wrought-iron frames, and finished off with polished wood moulding.

The interesting feature in this switchboard is the scarcity

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of voltmeters and the absence of pilot wires, with their usual attachments. Thus there are 18 ammeters used and only two voltmeters. The details of connection are as follow: On the negative board the dynamo and battery bars are horizontal, and are placed behind the board (Fig. 15), while the feeder bars are vertical, and are placed on the surface of the slab. The plugs connecting through from one bar to the other are constructed as follow: The end of the plug is screwed, and then the screw is cut away at two sides. The screwed hole is also cut away, so that the plug can be inserted to the full depth at once. Then a quarter turn causes the remaining portions of the screw to engage, and to tighten the front portion of the plug against the front bar. This construction enables connections to be made quickly, but the contact obtained is not so good as with the ground-in-plug type. On the positive section of the board the dynamo and accumulator bars are horizontal, and are on the face of the slab, while the feeder bars are vertical and are placed behind.

It will be noticed that the switches connecting the machines and batteries to their respective bars have two contacts. When the switch is on the first a resistance is in the circuit. On the ammeter there are small indicators showing the direction of the current, which are of use when paralleling the dynamos, etc. For instance, when a fresh dynamo is to be switched, there are no means provided for finding its E.M.F.; but as it is first inserted with resistance in series, this small indicator shows which way the current flows, thus showing what regulation is required. When this is correctly done, the indicator goes back to zero and the machine is switched in light. The same applies to the feeders, but it is not clear how the man in charge will ascertain the voltage at the far end of the network.

Mains.

The whole of the feeders and distributing network have been supplied and laid by Messrs. Siemens Bros. and Co. The cable is of the usual type manufactured by that firm, and consists of copper conductors having sectional areas varying from $\frac{1}{8}$ and $\frac{1}{4}$ up to $\frac{1}{2}$ square inch. They are insulated with pure and vulcanised rubber, then taped and braided over all. The braiding colour is varied to distinguish the positive, negative, and middle conductors from each other. The full-size sections of these cables are shown in Fig. 17. The cables are drawn into earthenware pipes, supplied by Doulton and Co., from brickwork distributing boxes. The $\frac{1}{2}$ square inch cables, and some of the $\frac{1}{4}$ square inch cables, are used as feeders, and are placed in 6in. pipes, while the distributing network is placed in 4in. piping, and consists of two cables of $\frac{1}{4}$ square inch sectional area and a middle wire of $\frac{1}{8}$ square inch area. The insulation of the cable is 2,500 megohms per statute mile when tested with an E.M.F. of 300 volts. The earthenware pipes are connected together by means of Stanford's patent joint, Fig. 18. In this invention a tight joint is obtainable by casting upon the spigot and in the socket of each pipe, by means of moulds prepared for the purpose, rings of cheap and durable material, which when put together fit mechanically into each other; and by making these rings of a spherical form, a certain amount of movement or settlement may take place without destroying the accuracy of the joint. When laying these pipes, therefore, all that is necessary is to insert the spigot of one fairly and firmly into the socket of another previously laid, the joint surfaces having previously been smeared with some kind of grease; the joint is then complete. In this way a joint is obtained that entails the least disturbance of the ground, and that does not necessitate the absolute drying of the trench bottom when it is being made. At Stafford the pipes entering the distributing boxes are formed with bell-mouths to facilitate the drawing in of the cables.

A map of the district in which mains are already laid is shown in Fig. 19. The circles in the street denote the position of arc lamps in a scheme for street-lighting now under consideration. Figs. 20 and 21 show details of the distributing boxes, which were designed by Dr. Hopkinson. The copper omnibus bars are supported on oil insulators attached to galvanised iron bars built into the brickwork of the box. The method of draining the cover frame is well arranged so that no moisture can get into the box.

Charges.

The committee have authorised a charge of 8d. per Board of Trade unit for all electricity used up to a maximum demand of $1\frac{1}{2}$ hours per day, and all units consumed above this quantity will be charged at 4d. per Board of Trade unit. Upon each consumer's premises there is fixed one of Wright's patent demand indicators. This plan recommended itself as the fairest and most equitable basis upon which to charge for electricity, both to the supply company and the consumer.

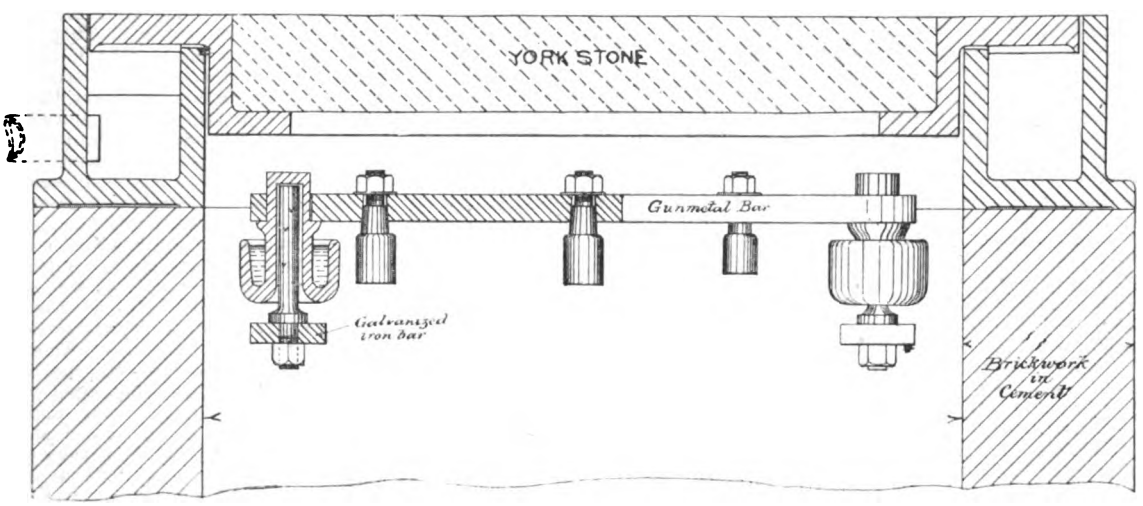

Fig. 21.—Section of Distributing-box.

Mr. Bell, who has had so much to do with the design and erection of the station, will be responsible for its running, and has appointed Mr. J. S. Highfield to be electrical engineer-in-charge.

We must congratulate the Electric Lighting Committee and their chairman, Mr. W. H. Peach, on the success which has followed their efforts to provide a thoroughly efficient electric lighting equipment for their fellow-townsmen.

Contracts Open.—Tenders are invited for the electric lighting of Miners' Hall, Ashington. Apply to Messrs. Boolds and Hardy, Morpeth.—The Bolton Union require tenders for the installation of the electric light at the Poor-Law Offices, Mawdsley-street. Tenders by 15th inst. to, and conditions from, Mr. Simpson Cooper, union clerk, 28, Mawdsley-street, Bolton.

Birmingham.—The lighting and distribution of power at the new technical school in Suffolk-street is done throughout by electricity. The engineering of the installation was placed in the hands of Messrs. Henry Lea and Thornbery, of Bennett's-hill, Birmingham, upon whose specifications and plans tenders were obtained, and who supervised the work after the order had been placed with Messrs. B. Verity and Sons, of London and Birmingham. The first instructions were given to the contractors about the end of May last, and the light was used for school purposes on September 16, and has since then been nightly in use without interruption. There are in all about 806 incandescent lamps and 80 arc lamps.

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LEGAL INTELLIGENCE.

PINK v. CAMBRIDGE ELECTRIC SUPPLY COMPANY, LIMITED.

In this case in the Cambridge County Court, Mr. Octavius Frank Pink, chief assistant in the Cambridge Free Library, was the plaintiff, and Mr. W. Cockerell (instructed by Mr. H. C. Squires) appeared on his behalf. The defendants were the Cambridge Electric Supply Company, Limited, for whom Dr. Cooper (instructed by Messrs. Ginn and Matthew) appeared. The case was tried before a jury.

Mr. Cockerell, in opening the case, said the action was brought to recover damages for an accident which, he contended, was due to the negligent work of the electric supply company in connection with the laying down of the company's plant. A clause in the provisional order, which was confirmed by the Act of 1890, made the company answerable for all accidents or injuries happening through the fault of anyone in its employ.

Mr. Pink said that about 9.30 on the night of the 27th of May last he was walking from the free library in the direction of Market hill, and when near Messrs. Hallack and Bond's shop the inside of his right heel caught against one of the "electric light boxes." It was a moderately light night, and he was walking at the rate of about three miles an hour. He was thrown heavily to the ground. When he got up he examined the box and found it at least ½in. above the level of the pavement. The box was not so high now as then. He was injured by the fall just below the knee-cap, and he was unable to walk the next day. The injury gave him great pain for three weeks, and he was not able to walk as before until about the end of July. If he had been able to go to London on May 28 he would have realised a profit of at least £2. 5s. in the purchase of a book.

Mr. Wherry, surgeon, said the plaintiff consulted him on the 30th of May. Mr. Pink had a torn wound across the right knee-cap, which was swollen, and witness advised him not to stand more than necessary. A month or six weeks would elapse ere Mr. Pink was able to walk as before.

Dr. Cooper, on behalf of the defendants, submitted that the accident occurred through Mr. Pink's own want of caution. The box was now in the same position as on May 27. The defendants were only responsible for any accident that might have occurred in consequence of the boxes being improperly laid down. The Corporation repaired the pavement, and it was the duty of the Corporation to keep the pavement at such a height that the boxes should not be above it If, however, the company was liable, he submitted that the claim for damages was a most exorbitant one.

Mr. John Henry Barker said he had been manager of the defendant company since June, 1893, and to his knowledge the box in question had not been moved since then. The day after Mr. Pink's claim was made instructions were given that the box should not be moved until the claim had been settled. If the pavement near any box was irregular the company notified the Corporation of the fact, and the Corporation had, from time to time, repaired the pavement, and no account in respect of the work had been sent to the company. The lid of the box in question was taken up last Christmas, but afterwards screwed down again to its former position.

Francis Gerald Holder said he examined the box in December last and found it all right.

Alfred Cole said he inspected the box in March last and entered the word "right" in his pocket-book. That entry meant that the box was level with the pavement.

George Arnott, wireman, in the employ of the company, said the box was now in the same position as on March 25.

This concluded the case for the defence, and his Honour and the jury afterwards viewed the box. On the Court resuming, **Mr. Cockerell** addressed the jury for the plaintiff.

His Honour, in summing up, asked the jury to answer the following questions: Was the box as originally laid down level with the pavement so as not to be a source of danger on account of inequality of surface; has the level of the box or any corner of it been raised since originally laid down; if it has been raised, was it raised so as to be a source of danger, in consequence of inequality of surface; if there was such inequality, was it the cause of the accident; was there any contributory negligence on the part of the plaintiff; and what, if any, damages are due to the plaintiff? His Honour added that he did not see the slightest trace of contributory negligence.

The jury found a verdict for the defendants, and judgment was entered for them with costs.

WESTERN ELECTRIC COMPANY v. BRUSH ELECTRIC COMPANY.

In the suit of Western Electric Company *v.* Brush Electric Company on patent No. 476,317, issued to C. H. Rudd, June 7, 1892, for a system of testing electric circuits, a final decree was entered on September 17 by Judge Showalter, of the United States Court, finding the patent valid, and infringed by the Brush Electric Company. The patent in question covers a system of locating grounds and other troubles on an electric light circuit, which consists in providing an artificial circuit of high resistance at the station, and adapted to be connected to a line circuit, the resistance of the artificial circuit being fixed and so apportioned between contact points that the attendant, by means of a testing set, may find the neutral point in the artificial circuit corresponding to the neutral point of the line circuit connected therewith. Claim 1 of the patent is as follows: "In an electric light system an artificial circuit containing high resistance of invariable amount, said artificial circuit being connected with the different sides of a dynamo machine while supplying current to a working circuit, said artificial circuit having its resistance apportioned between connecting sockets, in combination with a testing apparatus for determining the neutral point of said artificial circuit, substantially as and for the purpose specified."

COMPANIES' MEETINGS AND REPORTS.

WILLANS AND ROBINSON, LIMITED.

The ordinary general meeting of the shareholders of Willans and Robinson, Limited, took place on the 8th inst. at the Cannon-street Hotel, E.C., Mr. Mark Robinson, chairman of the Company, presiding.

The **Chairman**, in moving the adoption of the report (a copy of which appeared in our last issue), said that he had again to congratulate the shareholders on an encouraging and prosperous half-year. It was true that they had had what he might call a windfall, but even without that the results would have shown an advance on the previous half-year. A portion of that windfall had already been applied to depreciation, but the writing down of assets faster than strict book-keeping required was only another way of adding to the reserve fund. That they had done better in the last half-year was important for two reasons: firstly, they had had to bear the burden of much idle capital which did not at present help to earn dividend, and this must continue so for the next half-year until the Rugby works were completed; and secondly, the first half of the year was seldom, in a business point of view so good as the second. The Board hoped, therefore, that their action in continuing the 7 per cent. dividend would meet with the approval of the shareholders. They might have divided 12 per cent, but they had thought that if they kept up the 7 per cent. dividend during a period of transition, and continued all the time to increase their reserve fund, they would be fulfilling their past promises to the shareholders, and at the same time could give good hope of surpassing them in the future. Turning to the business of the Company, increasing orders must always be a source of congratulation, but these had been somewhat embarrassing to the business as they could not greatly increase their output at Thames Ditton, or, indeed, until the Rugby works were ready. Shareholders would naturally wish to know when that would be. So far as the machine shops were concerned, he did not think they would get tools to work before next spring, but the foundry might be ready before. It had been originally intended to start at Rugby with a large foundry and a small machine shop, the latter being kept subordinate to the one at Thames Ditton, but they had found that this must be reversed, and that Rugby must be the headquarters. Since they contemplated building larger engines they would require heavier tools, and obviously their engines ought from the outset to be erected at the place where the heavy machinery was. Some of the heavier tools would be moved from Ditton, and the larger ones left there would be engaged on repetition work done to template and practically under the supervision of a foreman. The directors were satisfied that at Rugby they would get very efficient shops at a cost which would compare very favourably with Thames Ditton. Their machine shops would be 50 per cent. larger, and their foundry would have an available floor space five or six times greater than at Thames Ditton, so that they would be able themselves to cast all they required instead of as now putting much of it out. Some of the machine tools had been already purchased, and had been set up for the time in an extemporised shop at Ditton. After mentioning that the debenture debt had been paid off and steps taken to also pay off the mortgage on their freehold, the Chairman said that the difficulties in the way of carrying out work on the Continent from here were such that they had thought it better to receive a reasonable rate of royalty from licensees. It was as important as it was difficult to get just the right people to take up business abroad, but as the result of a great deal of negotiation he thought they had got their engines into the hands of people who would do them full justice. He was sorry to say that they had not yet been able to get a Stock Exchange quotation, but the requirements as to the issue and payment up of shares were being complied with, and he believed that all that would be necessary would be for them to renew their application for a quotation in six months' time.

Mr. Erskine seconded the adoption of the report.

Mr. Rose asked if their licensees abroad were bound by the English price list, or allowed to sell at any price they found necessary.

Mr. Bryan Donkin expressed his satisfaction with the report. He looked upon an increasing reserve fund as a patent machine for equalising dividends. He would be glad to hear something as to their new French boiler and the increase in the item for patents.

The **Chairman** said it had been judged necessary to allow their licensees to fix their own prices. They could not, of course, come into competition with the Company in England, the United States, or any country covered by their patents. Any competition, say, in the far East, they looked upon as negligible. They would, of course, receive the royalty upon it, and if any business was done it would rather be additional to than in competition with what they might do themselves. The bulk of the increase under patents was for experimental work on a gas-engine. They had concluded

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that, had gained valuable information, and whenever they had space and time to take it up they would be able to go on with advantage to the manufacture of gas and oil engines. The particular patent in question they did not propose to take up. The Niclausse boiler promised very well indeed, but it was useless for them to take orders for it which they could not at present execute. It had cost them £5,000, but within a few weeks they had got back £1,000 of that for a sub-license. Some were already at work. They had been obliged to refuse an order from South Africa for seven, and it was understood that the Admiralty had decided to have one of her Majesty's ships fitted with them to try them. Most of their own work at Rugby would be done with the Niclausse boiler. In reply to other shareholders, the Chairman stated that most of their reserve fund was invested in consols. Their work for the Heilmann locomotives was going on satisfactorily, but was not delivered as the locomotives were not ready to receive it.

The report was then carried, as well as the formal motion for the declaration of a 6 per cent. dividend on the preference and a 7 per cent. dividend on the ordinary shares, and the meeting terminated.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Halifax.—Tenders are asked for the laboratory fittings required at the higher grade school, for the Halifax School Board. Particulars may be obtained at the offices of Messrs. Horsfall and Williams, architects, 15, George street, Halifax. Tenders to be delivered before noon on 14th inst.

Madrid.—The Director of Public Works invites tenders by November 15 for the concession of the construction and working of a tramway from Madrid to Colmenar Viejo, with branches to Chamartin and Rosa. Security, 12,505 pesetas. Particulars at the Direccion General de Obras Publicas (Ministerio de Fomento), Madrid.

London, E.C.—The Bengal and North-Western Railway Company, Limited, are prepared to receive tenders by October 16 for the supply of 22 copper tube plates. Specifications, with form of tender and general conditions of contract, may be obtained at the company's offices, 237, Gresham House, Old Broad-street, E.C., upon payment of 10s. each. Tenders must be addressed to Mr. E. L. Marryat, secretary.

Edinburgh.—The Lord Provost, Magistrates, and Council invite tenders for the wiring of the Waverley Market. Specifications and forms of tender can be obtained at the resident electrical engineer's office, 5, Dewar-place, Edinburgh. A deposit of £1 is required, which will be returned on receipt of bona fide tender. Tenders are to be sent to Mr. Thomas Hunter, W.S., town clerk, City Chambers, Edinburgh, endorsed "Tender for Wiring Waverley Market," before 10 a.m. on 12th inst.

Chepping Wycombe (Bucks.).—The Urban Sanitary Authority for this borough are prepared to receive tenders from public companies for working the electric order obtained by them within the borough for a term of years and upon approved conditions. Tenders are to be delivered by noon on October 14 next, at the office of the town clerk, High Wycombe, where a copy of the electric order may be seen and further particulars obtained. The Authority do not bind themselves to accept any tender.

Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

Killarney.—The Governors invite tenders for the lighting of the district asylum, Killarney, by any kind of illuminant, for 12 months from November 1. Printed forms of tender can be had from the clerk of the asylum on a deposit of £5 being made for each form issued. The deposit will be returned if the tendering be bona fide. Tenders will be received up to 12 noon on 17th inst. The declared contractor will be required to enter into a bond with two securities for the performance of contract.

Brussels.—Tenders are desired for the supply of copper cables and wire (bare and covered) required for the Telegraph Service—first lot, 1,300 to 2,000 metres of house wire with two conductors; 1,200 to 1,300 metres of the same; 300 to 400 metres of twin flexible; 700 to 900 metres of the same; 1,500 to 1 800 metres of the same—caution money, 1,700f.; second lot, 675 to 900 kilos of soft annealed copper wire of 12mm. diameter; 200 to 300 kilos of 16mm. diameter; 300 to 450 kilos of 20mm diameter; 155 000 to 200 000 metres of copper wire, G.P. covered with a layer of white cotton and a braiding of dark cotton; 87,000 to 110,000 metres of the same with a layer of tarred tape; 30,000 to 55,000 metres of the same with an incombustible covering; 2,500 to 3 500 metres of twin flexible—caution money, 3,500f. Particulars at the Administration des Chemins de Fer, des Postes, et des Télégraphes, Brussels. Tenders will be received at the Bourse, Brussels, up to October 16.

RESULTS OF TENDERS.

Blackburn.—The tender of Messrs. B. Verity and Sons, London and Manchester, has been accepted for electric lighting at the Town Hall.

Madras.—The tender of the Brush Electrical Engineering Company for the supply of the whole of the apparatus required for lighting the Arkonam railway station by electricity has been accepted by the board of directors of the Madras Railway.

BUSINESS NOTES.

Eastern Telegraph Company.—The receipts for the month of September show £5,218 increase.

Great Northern Telegraph Company.—For the month of September the receipts were £28,400.

Horsell (Surrey).—The Parish Council have discussed the question of lighting the village by electricity.

Eastern Extension Telegraph Company.—The receipts for the month of September show £12,500 increase.

Orkney.—The County Council have agreed to petition the Government for the extension of the telegraph to Orphir.

Dunfermline.—A correspondence has taken place in the *Dundee Advertiser* on the question of the electric light for Dunfermline.

Llanelly.—The Llanmor (Waddle's) Foundry will shortly be lighted by electricity by Messrs. J. C. Howell, Limited, of Llanelly.

Mile End, E.—The Mile End Vestry have appointed a committee of six to enquire into the advisability of lighting the hamlet by electricity.

Buenos Ayres.—An underground electric tramway is, says a Reuter telegram, about to be constructed in Buenos Ayres. Work will be begun shortly.

Direct Spanish Telegraph Company.—For the month of September the receipts were £2,072, against £1,898 for the corresponding period of 1894.

Halifax.—The Corporation electricity supply is now continuous, night and day. Numerous applications continue to be received for a supply of current for the winter.

Reading.—The Town Council have sanctioned the laying of a number of street mains and the execution of other works by the Reading Electric Supply Company, Limited.

Bury St. Edmunds.—The Town Council have appointed a committee "to consider if it be advisable for the Corporation to light the town by electricity, and by what means."

Western and Brazilian Telegraph Company.—For the week ending October 4 the receipts, after deducting 17 per cent. payable to the Platino-Brazilian Company, were £3,071.

Hampstead.—The Vestry Board-room is now ventilated by means of a Blackman electrical ventilator, which has been fixed in one of the windows under the supervision of the chief electrical engineer.

Godalming.—The Godalming Corporation have decided, by the casting vote of the Mayor, to acquire the waterworks at a cost of £48,000, and to obtain a provisional order for the installation of the electric light.

Worcester.—The Town Council have decided to apply to the Local Government Board to approve of their borrowing £1,300 for wiring the Guildhall and Public Hall for electric lighting, to be repayable in 25 years.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 6th inst. amounted to £1,088, as compared with £908 in the corresponding week of last year, being an increase of £180.

Brierley Hill (Staffs.).—The Urban Council have decided that the clerk be instructed to obtain from electrical engineers of repute information as to the probable cost of lighting the district by electricity in lieu of gas.

Poplar, E.—The Poplar District Board have decided to discharge the reference relating to the notice of the Capital and Counties Electricity Supply Company Limited, of their intention to light the district by electricity.

New Malden (Surrey).—The Urban District Council have decided, with regard to the offer of the Kingston Corporation to extend their electric mains into Coombe, to reply that in their opinion the matter would be premature at present.

Dewsbury.—The contractor for the electric lighting of the Industrial Hall is Mr. G. A. Steinthal, of Bradford. The wiring has been completed both in the hall and in the business premises. There will be about 130 incandescent lamps and two arc lamps.

Newport (Mon.).—Alderman Moses told the Council on Tuesday that the mayor was to be asked to open the central electrical works on Monday next, and at the same time to turn on the supply for the arc lamps which have been placed in the principal streets.

Colliery-Lighting.—Messrs. Clarke and Steavenson, of Lidgett Colliery, Tankersley, near Barnsley, have just electrically lighted the Barrow Hematite Steel Company's collieries, and have installed an 80-h.p. electric coal-cutting plant at the Astley and Tyldesley Collieries, near Manchester.

Killarney.—The annual election of Town Commissioners will take place on the 16th inst. The election will probably be fought on the lighting question again this year, and if candidates are put forward in the interest of gas *versus* electric lighting a close contest, a correspondent says, will be certain.

New Catalogues.—The Electric Construction Company, Limited, have issued a new catalogue, with revised quotations for their standard-size continuous-current dynamos. They invite

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attention to their speciality in Eickemeyer-wound drum armatures for high voltages, continuous-current transformers and motors.

Whitehaven.—A deputation from the Town Council Water and Lighting Committee have waited upon the Harbour Commissioners, and after a statement and discussion in reference to the electric lighting of the harbour, the deputation intimated that they would communicate further with the Commissioners thereon.

City and South London Railway.—The returns for the week ended October 6 were £887, compared with £892 for the corresponding period of 1894, being a decrease of £5. The total receipts for the half-year 1895 are £11,858, compared with £12,011 for the corresponding period of 1894, being a decrease of £153.

Anglo-American Telegraph.—The directors of the Anglo-American Telegraph Company, Limited, have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending September 30 of 10s. per cent. on the ordinary and 20s. per cent. on the preferred stock, less income tax.

Liberian Rubber Syndicate, Limited.—This Company has been registered with a capital of £30,000 in £1 shares Object: to acquire any lands, mines, mining rights, etc., in the republic of Liberia, and to develop and turn to account the same in such manner as the Company shall deem expedient. The directors are Lord Raglan, T. Bower, and C. Woermann.

Newquay (Cornwall)—The gas at Newquay being expensive and not very satisfactory, the directors of the Baths and Laundry Company decided to use electricity for lighting purposes and heating the irons of the mechanical ironers. The installation is now complete, and has been carried out by Messrs. J. S. Cunnington and Co., of 5, John-street, Adelphi, W.C.

Cheltenham.—The chairman of the Lighting Committee of the Corporation reports a gratifying increase in the demand for the electric light. In August the applications amounted to 2,060 8-c.p. lamps; this month they had risen to 3,376, 3,040 of which are actually connected, and are being supplied with the current. The electric lighting station is now running night and day.

Berkhamsted.—Mr. Newman enquired at the Parish Council meeting whether it was likely that they were to have the electric light. In reply, the Chairman said an application was recently made to the District Council, who expressed no objection to the electric light company making an application in the necessary quarter for permission. The District Council did not stand in the way of it.

Removal.—The Epstein Electric Accumulator Company, Limited, late of 215, Gresham House, Old Broad-street, London, E.C., inform us that, owing to the large increase in their business, they have found it necessary to remove their head offices to more commodious premises at Victoria-mansions, 28, Victoria-street, London, S.W., whither all communications in future should be addressed.

Southport.—The Electricity Committee of the Corporation have resolved that on the completion of the present extensions at the electricity works electrical energy be supplied during the whole of the day and night and that the committee placed on record their high appreciation of the ability displayed by Mr. B. J. Wolfenden in the designing and carrying out of the buildings, etc., for the electricity works extensions.

Hull.—A Local Government Board enquiry has been held by Mr. Rienzi Walton, C.E, with reference to the application of the Corporation for permission to borrow £8,000 for purposes of electric lighting. The amount is required to meet the requirements necessitated by the increased demand for the light. Mr. A. S. Barnard, of Lancaster, has been elected to the post of electrical engineer to the Hull Corporation.

Mevagissey (Cornwall).—The Parish Council have received the report of the Electric Light Committee, which showed that the scheme for forming a company was meeting with scant success. Messrs. Veale and Co., of St. Austell, had promised to take £300 worth of shares, and £250 had been promised by people of the town towards the £1,300 required to float the company. The Council decided to give the committee a month more to continue their labours.

Aberdeen.—The Town Council have referred to the Gas and Electric Lighting Committee a letter from the Building Committee of Free Bon-Accord Church to the effect that the committee had been considering the propriety of introducing electric lighting in the new church on the Viaduct, and they wished to know whether, in the event of their seeing their way to do so, the Town Council would extend the mains as far as would permit a supply of the illuminant being given for the new building.

Burton-on-Trent.—In moving the adoption of the report of the Gas and Electric Lighting Committee of the Town Council, Alderman Lowe mentioned that they had agreed to illuminate the parish church clock free of charge. They had also had under consideration the advisableness of using the electric light in the streets in which the cables were laid, but after receiving a report from the manager (Mr. Ramsden) they came to the conclusion that it would be best to postpone further consideration for a time.

Tunbridge Wells.—Councillor Wood has moved the adoption of the Corporation Lighting Committee's report, which showed that the electric system was now in use over a large part of the borough, and that applications for the new light came from all quarters. Alderman Cronk expressed the hope that at the end of such streets as Church-road and York-road the gas lamps would be lit as well as the electric lights, so that a light might be thrown along the side streets. The committee undertook to consider the points raised, the Mayor touching upon the numerous advantages of the electric light over gas in the streets.

Wakefield.—The Electric Lighting Committee have been making steady progress with the proposed electric lighting works for the city. They have tenders for the works, and they hope before very long to have everything in order pending the decision of the Local Government Board as to borrowing powers. It is understood that there is a necessity for pushing on with the work, because some large customers are waiting who, if the Corporation did not provide them with the electric light, would probably supply themselves.

Appointment Vacant.—The Blackburn Corporation are prepared to receive applications for the appointment of assistant engineer at the electricity works. Applicants must have had experience in similar situations in both high and low tension stations. Salary, £130 per annum. Applications, endorsed "Assistant Electrical Engineer," stating age and experience, and accompanied by not less than three testimonials of recent date, to be sent to Mr. Robert E. Fox, town clerk, Town Hall, Blackburn, not later than 19th inst.

New Catalogue.—The United Asbestos Company, Limited, of Billiter-street, London, E.C., send us a copy of their new illustrated catalogue, which is claimed to be the most complete issued in the asbestos trade. The special features therein are their "Victor" metallic joints. "Salamander" joints, "Gladiator" packing, and particularly their new asbestos patented "Salamander" embossed decorations, which are said to be an entirely novel adaptation of asbestos, and likely to prove efficacious in preventing the inception and spread of fire wherever used, either in saloons of vessels or in buildings.

Bradford.—The half-yearly statement as to the profits of the Corporation's gas and electricity works shows that the capital account for electricity works was £67,111, and the income for the year £6 185. The expenditure had been £3,008, the trade profit was £3,176, interest and sinking fund had absorbed £2,190, and the net profit was £986, as compared with £2,138 for the preceding year. The electricity department consider they have been handicapped by their boilers, and the fact that the new engines and plant had not been delivered, but the works are thought to be in a fair way of becoming an appreciable source of income.

St. Albans.—The Town Council have considered an application from the Bedford Electric Light Company, Limited, for the consent of the Council to a proposed application by the company to the Board of Trade, under the Electric Lighting Acts, 1882 to 1888, for a provisional order to authorise the introduction of the electric light into the city of St. Albans. It was decided, on the proposal of Councillor Bowden, seconded by Councillor Watts, that the consent of the Council to the proposed application could not be granted, both mentioning that the subject had been thoroughly gone into on a previous occasion. There were weighty reasons why the application should not be entertained.

Durham—The Postmaster-General has written acknowledging receipt of the letter of the clerk to the Durham Rural District Council as to telegraph extension at Kelloe, and enclosing draft agreement for approval by the Council. The clerk read the draft agreement, which was to the effect that if in any 12 months succeeding the laying on of the telegraphic connection to Kelloe the gross receipts should be less than £31, the guarantors and their successors shall within 14 days pay such a sum of money as altogether, with the gross receipts for telegrams, should make up the £31, and any sum in excess of that shall be taken into account for the subsequent year; also that the occupancy be terminable by the Postmaster.

Leeds.—On Wednesday, as an amendment to the motion of Alderman Sir E. Gaunt, proposing the confirmation of the minutes of the Corporation Property Committee, Mr. J. F. Carter moved that the portion of the minutes containing a resolution in favour of the sale of the whole of the electric lighting plant be referred back to the committee. Mr. Denison seconded the amendment, which, after considerable discussion, was lost. Mr. John Gordon then moved that all the plant be sold, with the exception of one gas-engine. He thought one engine should be retained until arrangements could be made for a hydraulic apparatus to work the hoist to the free library. Alderman Sir E. Gaunt seconded this amendment, which was carried.

Glasgow.—Anent the proposed electric traction, a correspondent writes to a local paper: "I had an opportunity recently of being in Brussels, and I cannot see why anyone can say that the trolley-wire system there is a disfigurement to the streets. The cars work with remarkable smoothness and no noise, and it surprised me to think that we in Glasgow should be so far behind the times with our horse cars, when here was a system that would suit us exactly. The sooner we have electric traction on the cars the better." Mr. Nelson has given notice to call the Police Commissioners' attention to the manner in which Glasgow is lighted with the electric light. He considered that the city was the worst-lighted city in Europe.

Bangor (N.W.)—The Bangor City Council resolved on Wednesday to apply to the Board of Trade for a license to supply electricity within the limits of the borough, and such parts, if any, of the parishes of Llandegai and Pentir as may be thought desirable; and to apply for a provisional order at the earliest opportunity. The minutes of the Electric Lighting Committee of the Council, which were adopted, included a recommendation that Mr. Medhurst be appointed electrical engineer (providing the Council obtain the necessary powers to proceed with the scheme) at a remuneration of £650. If, however, the Council deem it prudent not to proceed further than to obtain the necessary power to

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proceed, that Mr. Medhurst be paid £50 in full discharge of all claims.

Eastbourne.—The Telephone Sub-Committee of the Town Council have submitted for consideration a further extension of the borough private service of telephonic communication by the installing of wall-box speaking instruments and fire-calls, to be placed as follow, the amount denoting the cost of purchase and fittings: (1) The Shelters, Grand-parade, £32. 9s.; (2) opposite the gates of Ocklynge Cemetery, £45. 7s.; (3) Seaside road, opposite Royal-parade, £26. 13s.; (4) at Gearnip (end of parish), £34. 10s.; (5) chief constable's private house, £31. 19s.; (6) Devonshire Park, £21. 16s. The committee resolved that by way of experiment a telephone wall-box and connection be constructed from the police station to the Parade.

Enfield.—The Enfield District Council have received a letter from the Town and Village Electric Light and Power Company, stating that the terms of their business were so arranged that the revenue obtainable from the plant it supplies covers the cost of both installation and maintenance. The company offered, on receipt of information as to requirements of the Council, to send a *pro formâ* tender and demonstrate how the results mentioned could be attained. Mr. Medhurst wrote offering the Council his services as consulting electrical engineer; Mr. Theodore Ellis of Enfield, wrote asking the Council to give permission for a number of inhabitants to obtain a provisional order, and all these communications were referred to the General Purposes Committee.

Alderley Edge (Cheshire)—A sub-committee have reported to the District Council that they had had an interview with Mr. Clirehugh, electrical engineer, of Manchester, in reference to the purchase of the electric lighting provisional order. Mr. W. G Groves said a draft agreement had been drawn up and clauses had been inserted safeguarding the interests of the Council. He would move that the Council enter into an agreement upon terms satisfactory to the Council. The motion was carried. Dr. Burghardt said that if the Council sold this provisional order, and if they had to wait some time, they would be in an awkward position. They would have to pay the bill of £272 for the order they had received. In the end the Council decided to call another meeting to further consider the electric lighting question.

Belfast.—The Electric Committee of the Corporation have met, under the chairmanship of Alderman Pirrie, J.P. The engineer (Mr. V. A H. M'Cowen) submitted a report on the proposed extension of mains in Arthur-street, Howard-street, College-square North, College square East, and Wellington-place, together with the estimates as to the probable cost, and he was authorised to proceed with the extensions. Tenders for the supply of additional engines and dynamos in the central station were submitted to the town clerk and referred to the engineer for a report. The building at Larne for the British Aluminium Company is rapidly approaching completion. The machinery is being supplied by Messrs. Victor Coates and Co., of Prince's Dock Foundry, Belfast. The cost of the erection will be, it is stated, £16,000.

Dover.—The Town Council have received a letter from the electric supply company, enclosing plans showing the proposed position of the arc lights in Snargate-street, and stating that sanction had been obtained in all cases except one. Councillor G. Mowll said he did not think the chairman knew of the way in which the electric light company's servants carried on the work. He referred to the dangerous manner in which the transformer-chambers were left open with often no cage on them. He asked on whom the responsibility would fall if someone fell down, an accident which, according to Councillor Thorpe, had already occurred. Two alternative proposals for the alteration of the arc lamps from the Monument to the Market-square were also forwarded by the electric lighting company, and referred to the Town Ward Committee.

A Bankers' Strong-room, weighing upwards of 20 tons, and valued at £1,000, has been completed this week at the works, in Wolverhampton, of George Price, Limited, bankers' engineers. The room has been specially constructed for Messrs. Beckett and Co., bankers, Leeds, and is claimed to be one of the largest, heaviest, and most scientifically constructed strong-rooms ever turned out in the Midlands. It is 15ft. 3in. long, 11ft. 3in. wide, and 12ft. 3in. high, and is composed of plates, case-hardened all over, and absolutely drill, burglar, and fire proof. The door-plate is 2in. solid case-hardened metal over the lock, and the door, together with the inner gate, weighs two tons. At the rear of the door is an electric alarm, which communicates with the manager's room, and which rings when the door is opened. The interior is to be fitted up with electric lights.

Barnet—A resolution in Mr. Bampfield's name at the Urban Council's meeting was as follows: "That the Council consider at once the best method of dealing with the question of electric lighting so as to satisfy the requirements of the provisional order." The General Purposes Committee, he said, had been considering the whole question of electric lighting without any instructions from the Council, and he was afraid lest the matter might be rushed through without full consideration. He complained, also, that the new members of the Council (as distinguished from members of the Local Board) were not represented upon the committee, although they were returned, with the aid of the Ratepayers' Association, to oppose any undue haste in bringing the electric light into the town. For the motion there voted only the proposer, and it was therefore rejected.

New Issue.—The Salt Lake and Ogden Gas and Electric Light Company, Limited, announce the issue of 100,000 shares, part of 150,000 5 per cent. cumulative preference shares of £1 each. The company was formed in 1893, with a share capital of 1,500,000dol., for the purpose of acquiring the franchises extending to the year 1918 and consolidating the several undertakings previously carried on in Salt Lake City and Ogden for the supply of gas and electric light and power in both these cities. That company created an issue of 1,500 000dol. (£300,000) 6 per cent. first mortgage gold bonds, specially secured by a registered mortgage in favour of the Farmers' Loan and Trust Company of New York, as trustees upon the consolidated properties, whereof 1,250,000dol. (£250,000) have been issued, and the interest regularly paid.

Hammersmith—Tenders for the electric lighting installation have been received by the Hammersmith Vestry from several firms, and are now before a sub-committee. The Electric Lighting Committee reported that, having considered the circular letter from the City of London Electric Lighting Company, referring to a recent case in the Court of Appeal, stating that it was intended to convene a meeting to determine upon a course of action with the object of obtaining an amendment of the law that will give reasonable protection to undertakers and at the same time secure full compensation to all persons and bodies interested for all damage caused by the user of any electric light works, they were advised that this object would be attained were a general Act of Parliament passed containing a clause in the form they proposed. The Vestry decided to send the chairman and vice-chairman to the meeting as delegates.

Ladders for Electric Light Work.—The great difficulty of using ladders upon wheeled carriages in uneven roadways and upon hillsides has now, it is claimed, been overcome by Mr. Heathman's recent improvements, and the Heathman patent telescopic ladders recently sent to Ealing, Tunbridge, Bray, and Taunton installations for recarboning the street arc lamps are said to be adjustable quite perpendicular even when one side of the carriage is in a deep gutter or upon a high pavement. In addition to which it is stated that the ladders can swing to any angle of inclination; and the hand levers for wheeling are now made telescopic, so as to slide out of the way when the ladders are in use. Messrs. Heathman and Co., of Endell-street, have now opened a special department for lending any of their manufactures on hire to wiring contractors, who can avoid the cost of erecting expensive scaffolding by borrowing Heathman's patent tower ladders, which are made to telescope up to 60ft.

Nottingham.—On April 8 the following resolution was passed: "Resolved that the borough accountant be paid an additional salary of £100 per annum as accountant and collector to the electric lighting department" With the view of obviating the question of having an independent staff for the Electric Lighting Committee to keep accounts and to collect rents, the Finance Committee had made an arrangement with Mr. Bryan to take over the additional work at a remuneration of £100 per year Alderman Goldschmidt said at the last meeting that the Council would understand that by making that arrangement they had effected a great saving, because if the Electric Lighting Committee were to have an independent staff it would cost not one hundred but many hundreds of pounds The Finance Committee, in making that appointment, were of opinion that they were acting strictly within the powers assigned to them. If, however, the Council so desired, they were perfectly prepared at an early date to bring up a full report on the question.

Harrogate.—The Electric Light Sub Committee have reported to the Town Council that they had carefully gone through the detailed estimates laid before them by the electrical engineer, amounting, together with contingencies, to the sum of £23,500 for buildings and plant required for the installation of the electric light in Harrogate, as provided by the order of 1891, and they recommend that the detailed estimates submitted be approved and forwarded to the Local Government Board, and that the Board's sanction be asked to a loan for that amount, and also for a further sum of £1,500 for the purposes of street-lighting by electricity. The report was adopted by the Council, the Mayor (Mr. Fortune) explaining that they would have to await the sanction of the Local Government Board before proceedings could be taken and in the meantime they would get further information, and would be able to let the contracts in a fortnight or a month, as the case might be. It is proposed to have about 68 arc lamps in various parts of the town, and also to light the new baths electrically.

Kingswood (Bristol).—The following letter has been received from the tramways company by the Urban District Council: "I am instructed by my directors to thank you for your letter of the 19th ult., and they have given the matter their careful consideration, and regret they cannot comply with the whole of the conditions named by your Council. The plan which you have specifies the exact widths, and I think upon careful examination these will be found satisfactory. With regard to the wood paving and the question of applying for further parliamentary powers, these are matters upon which the directors are unable to give any undertakings, but they will be pleased to carry out the widening of the roadway for the whole length of the company's property, as shown in the plan, and to bear the whole expense of the adjacent footway; and with regard to the advantages which will then be secured by your district, I am instructed by the directors to express a hope that the plan enclosed with my application of the 17th inst. will receive your Council's approval at their to-morrow's meeting, so that the work may proceed forthwith —S. WHITE, secretary." This communication, which referred to the extension of the company's line to their yard at Warmley-hill, received the Council's approval.

Bolton (Lancs.).—Mr. Deakin moved, at the Guardians' meeting, that it be an instruction to the Decoration Committee to have the electric light installed in all the rooms of the union offices

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except the Board-room and lavatories. He enumerated some of the advantages of having an electric installation, observing that the main objection which those who had spoken against it had was one of economy, but on this point he yielded to no one on the Board in his desire to exercise economy. He proceeded to show that an installation of electricity in that building would be more economical than gas, comparing the difference in cost between 100 electric lights and 100 ordinary gaslights, taking it on a basis of 500 hours burned per annum. The cost of gaslight, he said, was £46. 5s. and electric light £29. 9s , giving a saving in favour of electricity of £16. 16s. On the score of health he contended that electric light was preferable to gas, and in a decorated room the fumes from the gas had an effect on the decorations. Mr. John Taylor seconded, and Mrs. Ashworth supported, remarking that it was desirable from a health point of view that the electric light should be put in After some discussion Mr. Cunliffe moved that the electric light be introduced, and that tenders for the same be obtained. This was adopted by 29 votes to 15.

Edinburgh —On Tuesday the Cleaning and Lighting Committee of the Corporation recommended that the Grassmarket and West Bow should be lighted with electric light at a cost of £140. The Treasurer said he agreed that no more suitable place could be had for the electric light than the West Bow and Grassmarket; but since they framed the estimates they had passed electric light for George street at an expenditure of £880 per annum, and for the Mound at £160 per annum, or £1 040. He thought it would be better if the Cleaning and Lighting Committee could see their way to postpone this till next year Bailie Steel said his committee were very desirous that they should not go any further in this matter, but they felt that this claim of the Grassmarket was a very strong one, as the light in that district was insufficient. However, before they went further he thought they should have a general scheme for future extensions. Mr. Mackenzie (convener of the Electric Light Sub-Committee) agreed that they should pass the Grassmarket extension. The Cleaning and Lighting Committee also recommended the erection of an electric lamp at the corner of Picardy-place and another at the corner of London-road. This proposal, however, was sent back to the committee for reconsideration.

Copper.—According to a despatch from Houghton. Michigan, this year's output of copper by the Calumet and Hecla Company will be nearly 20,000,000lb. more than last year, an increase of one-third. Messrs. James Lewis and Son's monthly report on copper contains the following: A fairly large business has been done in good merchantable copper during the past month, the turnover being 20,000 tons as against 25,000 tons in August The chief feature of the market during the last month has been the large business done in "the call" of copper, 20s. being paid for the call of 3 000 to 4,000 tons at three months' date, and 8s. 9d. for the call of 300 tons at one month's date. Sellers of argentiferous pig copper and other furnace material have moderated their views somewhat, and a large quantity of matte and argentiferous bars has been sold in America to smelters in this country. Electrolytic copper is in fair demand for the Continent, and most manufacturers are fully sold for some time ahead. American shipments to Europe for September are 4 075 tons, making the total to date this year 48,918 tons, against 60,495 tons in the same period last year. Imports are 5,746 tons less, and deliveries 1,164 tons greater to date than during the same period last year. The total arrivals in England and France for the month have been 5,535 tons, and the deliveries 7,674 tons fine Stocks have decreased 2,139 tons. The arrivals in England from Chile during the month have been 1,376 and the deliveries 1,758 tons fine, and from other countries 2,397 and 3,477 tons fine respectively The arrivals in England from the United States have been 369 tons bars, 36 tons ingots. and 461 tons matte, equal to about 654 tons fine copper, and in France 150 tons fine. The Chile charters for the month are advised as 1,500 tons, and exchange 17⅞.

Weybridge.—In the course of a discussion on a gas contract, at the Urban Council meeting, a member said he saw in the report of the last meeting of the Council that Mr. Jarvis made a statement that it was found impossible to raise the £5,300 necessary for the purchase of the electric light works; but he quoted an article to prove that these were the days of cheap money. and that there need be no difficulty in procuring what was wanted at a fair interest. He thought the private consumers of the electric light had been badly treated, and it was discourteous of the Council not to have expressed some sympathy with them in their application. The speaker sincerely sympathised with those gentlemen who had wired their houses. What, he asked, was the proper course for them to have adopted? They ought first to have accepted the offer of the electric light company to continue the light for three months. They would then have had an opportunity of negotiating with the electric supply and the gas companies, and, by playing off one against the other, they would have got more advantageous terms. The electric supply company had offered to light them at £3. 7s. 6d. per lamp, and give them the option of continuing the light or of purchase. But they had never tried that. Then, again, the electric supply company had been asked for a guarantee, but what guarantee had they with the gas company? He felt that they had not been fairly treated. If they wanted a gas contract, by all means let them have one; but it should be done in a straightforward manner.—A communication has been received from the Board of Trade, stating that the Weybridge Electric Supply Company proposed to revoke the order allowing them to light the village, and asking if the Council had any suggestions to make on the subject. Upon the suggestion of Mr. Ward, it was agreed to write to the Board of Trade asking on what terms the order could be transferred to the Council.

Islington, N.—A correspondent writes: "The Electric Lighting Committee of the Islington Vestry have found it necessary to apply to the Vestry for £25,000, in addition to the £60 000 already sanctioned for electric works in the parish. The increase seems to be a result of under-estimates, together with the acquisition of more property in Eden-grove for the electric station than the original scheme included. The committee report that machinery working to the extent of 1,000 h.p., and capable of serving 11,000 incandescent lights of 8 c p. each, or their equivalent, and 100 arc lamps for street lighting, is now being erected at the station. The present station will, it is said, with very slight alterations, afford sufficient accommodation for further machinery, equal to between 3,000 h.p. and 4,000 h.p., sufficient for a very considerable extension of both the public and private lighting. The necessary works and appliances for lighting the leading thoroughfares of the parish extending from the Angel Hotel, along Upper-street, and the Holloway and Seven Sisters roads, to Finsbury Park, are rapidly approaching completion, and it is hoped that this portion of the parish will soon be lighted. Already the committee have entered into provisional contracts for the supply of private consumers, and the ratepayers of Islington are emboldened to hope that Islington, like St. Pancras, by retaining the supply of electricity in the hands of its local authorities, may ultimately reap a profit from the undertaking that will serve to reduce the local rates. The profit of a year's working in the neighbouring parish of St. Pancras was equivalent to a dividend of 6 per cent. It is an advantage to the Islington scheme that the London County Council have recently reduced the rate of interest on loans for electric purposes, repayable in 42 years, from 3 to 2¾ per cent." The London County Council have agreed to lend the Islington Vestry £5,150 to purchase property for the extension of their electric lighting works.

London (St. James's).—The St. James's Vestry have considered a report of the Works Committee cn the desirability of lighting the main thoroughfares with electric light, the best system of electric lighting for such thoroughfares, the estimated cost as compared with gas, and generally upon the whole question. The committee have, it appears, had before them schemes submitted by the St James's and Pall Mall Electric Lighting Company and the London Electric Supply Corporation for the lighting of the parish, together with observations by the vestry clerk on the schemes. The general manager of the St. James's and Pall Mall Company had, in answer to enquiries by the vestry clerk, sent a letter in which he pointed out that in four cases they proposed the removal of street refuges. Piccadilly presented some difficulties, and, together with the circus, would require special treatment. A total of 69 lamps was shown, and the arrangement for connecting these lamps was drawn in diagram on the Regent-street circuit. In the event of this company undertaking the laying of mains for the purpose, it is estimated that a sum of £5,000 would be required, and, subject to a satisfactory arrangement as regards the period of the contract to enable the company to make provision for this capital outlay, they have expressed themselves as willing to supply energy and to maintain in full running order each of the lamps requiring a current of 10 amperes for £30 per annum, the Vestry supplying and erecting the lamp posts complete with lamps, and the company supplying all mains, connections, switches, and other gear as required. The Vestry have, however, decided before proceeding further with the question to instruct the surveyor to fit several lamps in Regent-street with burners of different size and incandescent burners for the purpose of experimenting as to the possibility of improving the lighting of the main thoroughfares by means of gas. It was also decided to place an arc electric light over one of the refuges in Regent-street by way of experiment.

Coseley (Staffs.).—Mr. C. W. Shackleton, engineer and surveyor to the Coseley District Council, has presented a report on the lighting of the district. Estimates are given for lighting by oil, by gas, by incandescent gas, and by electricity, together with statistics collected from 55 towns as to the number of hours of lighting and the cost and consumption of gas, cost per lamp per annum, etc. With regard to an electric installation, Mr. Shackleton states that it is possible to light up straggling districts like Coseley with an electric light installation on the incandescent system; but he is convinced that without private lighting an electric installation for street-lighting would be too expensive for a place like Coseley, and therefore out of the question. The engineers he has consulted are agreed that the only system by which an extended, scattered, and thinly-populated district like Coseley can be effectually lighted at a moderate cost is that known as the high-tension alternating-current series system. For this scheme the district would be divided into eight or nine circuits, and supplied with current from the central generating station, and the best place this could be erected is on the Council's land at Roseville. The wires would be insulated and carried on poles overhead, and not underground, the former being the cheapest arrangement, but the provisional approval of the Board of Trade should be obtained for the permanency of the arrangement. In considering the electric question the Council must ask themselves the question whether they would undertake the electric lighting of their own district, or allow it to drift into the hands of a private company. To efficiently light up the whole district from 350 to 400 16-c.p. lamps would be required, with, say, from 20 to 50 75-c.p. junction lamps. To do this and provide for 2 000 8-c.p. lamps for private lighting, by way of a start, plant would be required which would cost between £12,000 and £14,000, the annual estimated cost being £1,555; but if 2,000 private lights were taken up, at least £1,000 per annum would be received as revenue. Mr. Robert Hammond

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estimates that it should ultimately reach £2,000. For public lighting only the plant would cost £8,700, and the annual working expenses £1,226, equivalent to a rate of 6d. to 7d. in the pound. It has been decided to call a special meeting of the Council to consider the report.

South Staffordshire Tramways.—The Highway, Market, and Stables Committee of the Wednesbury Town Council have reported, with reference to the South Staffordshire Tramway Company, that the committee had asked the company to proceed with necessary repairs of the permanent way forthwith, and that the Board of Trade had granted an extension of time for the use of steam on the Wednesbury, Tipton, and West Bromwich lines until the end of the present year. Mr. Oldbury, in bringing up the report, expressed his satisfaction to find that the repairs were being made vigorously, and said he saw that someone at Tipton had said that Wednesbury and Darlaston were content with the existing state of things in respect to the tramways. That certainly was wrong. Wednesbury had always complained of the neglected condition of the permanent way, and had always deprecated and opposed any break of the communication between Wednesbury and Birmingham such as was proposed by the West Bromwich authorities. The Council ought to be quite prepared to go before the Board of Trade, if necessary, to fight for their rights—viz., the maintenance of the communication between Wednesbury and Birmingham. The Mayor said they had always expressed themselves favourable to an extension of the electric system; but Mr. Joynson considered they had never pledged themselves to any system Alderman Lloyd dissented from Mr. Oldbury's view that, if the cable system were laid as far as Carter's Green, Wednesbury would be cut off from Handsworth and Birmingham. Rather, as the cable gave a quicker movement than any other system, they would be able to get from Wednesbury to Birmingham in less time than under the present system. He hoped the Council would do their utmost to abolish the steam system to Handsworth, and, with the concurrence of the West Bromwich authorities, to introduce the electric system. The Mayor said that Wednesbury and Tipton would be quite satisfied with that system, but he did not think they ought to disagree with West Bromwich and Handsworth if those places wanted the cable. Mr. Griffiths argued that if the cable system were brought as far as Carter's Green it ought to be continued into Wednesbury, but Alderman Kilvert and others considered that could not be expected because of the cost, which the company could not bear, and engineering difficulties.

Oswestry.—With regard to the electric lighting of the Cross-market, it was stated at the Town Council meeting that the Oswestry Electric Lighting Company were prepared to supply six 500-c.p. lamps at £40 per annum, the cost of the gas-lighting at present being £42 3s. 6d. The tender of Mr. Reakes, of Shrewsbury, for the installation of the lighting at £52 was accepted. A correspondent writes: "Many of the principal residents and tradespeople of Oswestry are at present greatly interested in the lighting of the town by electricity supplied by the Oswestry Electric Light Company. A company has been formed with £10,000 capital, issued in 10,000 £1 shares. The registered office is at Albion-chambers, Oswald-road, the secretary being Mr. W. W. Coulson. The chairman of the directors is Mr. A. Wynne-Corrie, Park Hall, Oswestry, the other directors being Mr. G. Perks, mayor of Oswestry, Mr. Robert Lloyd, Rhianva, and Mr. Josiah Jones, Salop-road; while Mr. E. Bremner Smith is managing director and engineer, Mr. H. J. Wallace Pugh, solicitor to the company, and Mr. C. E. Williams, auditor. The bankers of the company are Lloyd's Bank. The company have, under the superintendence of Mr. E Bremner Smith, who prepared the plans and specifications and carried out the work of erection, built a commodious engine-house in the Coney Green. The building is equipped with two 60-h.p. steam-engines with boilers of the multitubular type, which drive two 30-kilowatt shunt dynamos. The dynamos are driven by eight ropes from each engine. Between the steam-engines is a water-heater for utilising waste steam. The engines are by Messrs. Marshall and Sons, of Gainsborough, whose local agents are Messrs. John Minshall and Co., of Oswestry. It was not originally intended to run both engines simultaneously, but from the large demands for the light it is expected that both engines will have to be run shortly. The system of distribution is the low-tension at a voltage of 105. The current is transformed up from 100 to 145 volts for charging the storage batteries. Above the motor is a switchboard, supplied by Messrs. Parker and Co., of Wolverhampton, with a double-pole switch of an improved type, double-pole fuses, ammeters, and Kelvin voltmeters. The battery-room contains D P. batteries consisting of 55 cells. The cables, by Messrs. Callenders, of Erith, are laid in earthenware conduits under the footpaths. The engines began running permanently on Monday week. Considerable interest has been aroused by the installation at Mr. Robert Lloyd's establishment in Cross-street, which includes a 1,000-c.p. lamp at the centre of his buildings, which illuminates the neighbourhood."

Electric Mining Plant.—Last Saturday a large company of mining engineers and others visited the works of Messrs. Ernest Scott and Mountain, Limited, electrical and general engineers, at Close, Newcastle-on-Tyne, the chief object being an inspection of some very fine and powerful electric transmission plant constructed by the firm for the St. John d'El Rey Mining Company, and to be used in the company's Morro Velho mines in Brazil. The plant consists of two 50-unit 750 volts special Tyne dynamos, with sliding bed-plates; one main switchboard with measuring instrument, and main and underground cables; two electric winding cases, each fitted with Tyne electric motors of 30 effective horse-power; one air-compressor, driven by a 30-h.p. Tyne electric motor; and two fans combined with Tyne electric motors, switches, resistances, etc. The dynamos are of Scott and Mountain's improved mining type, and are each capable of easily giving an output of 70 amperes, 750 volts, at 650 revolutions per minute. The main switchboard is designed for using two lines of cables, and it is fitted with two voltmeters, each to read to 800 volts; two ampere-meters, to read to 100 amperes; and two double-pole quick-break main switches and double-pole fuses. Where the current is taken underground it is conveyed by 2 700 yards of $^{19}/_{16}$ cable, very heavily insulated with vulcanised indiarubber and armoured with galvanised-iron wires. There are two winding gears, each driven by Tyne electric motors of 30 effective horse-power, with a speed of 500 revolutions per minute. Each gear is designed to lift vertically a load of 3 800lb. at a speed of 120ft. per minute. Three motors are provided, two being utilised for driving the winding gears, and one for the air-compressor. Each motor is capable of easily giving 30 effective horse-power at 500 revolutions per minute, and is of the firm's improved type. Special starting switches are provided, so that the motors can be stopped, started, or reversed, or run at any speed. These are of special design to avoid sparking, and at the same time prevent the current being too suddenly switched off, which might damage the insulation of the machines The air-compressor is provided for supplying air for rock boring and other operations at the mines. It is fitted with a cylinder, 12in. in diameter by 16in. stroke, and runs about 600 revolutions per minute. Two steel receivers are provided for storing the compressed air. Two of Scott and Mountain's electric fans are supplied for ventilating the mine, etc. Each fan will deliver about 3 000ft. of air per minute at 2in. W.G., and is fitted with a single inlet impeller of 24in. diameter and performing 1,000 revolutions per minute. The plant was much admired by the large number of experts present. In other parts of the works—which, by the way, are at present undergoing important extensions—there was much to interest the visitors. Messrs. Ernest Scott and Mountain are at present extremely busy in all departments of their business. Besides colliery pumping machinery, a very large number of electric light installations are in hand.

Swansea.—Alderman Richard Martin has moved the adoption of the Corporation Electric Lighting Committee's scheme. He said they were told Swansea could not afford such a scheme; that they were spending a lot of money on the market, the Cray water scheme, sewerage, etc. These people had forgotten to include the widening of the streets. That ought to have been put in. But he wished them to understand there was a significant difference between those schemes and the one now before them. The electric lighting scheme would pay for itself, and would in a short time become a lucrative monopoly. They asked the ratepayers to secure the control of a necessary and not an expensive monopoly, but one which would be very lucrative, and confer upon them privileges they did not now enjoy. A few years ago he (Mr. Martin) wanted the Corporation to take over the gasworks company. He was sorry he failed. He thought the gas company were very badly advised. while the Corporation were just a trifle too selfish—they were fearful of the electric light. His claim was that if the Corporation had taken over the gasworks they would have secured a very valuable asset. He appealed to them not to allow the electric lighting of the town to go into private hands, and if they would do what he advised them to do they would yet take over the gasworks. Even the Cray scheme would eventually prove lucrative, providing it was properly worked. He did not think Swansea people wished to be behind the age. They had been badly treated by the gas company, and if properly treated by the Corporation he was sure they would assist them in making the electric scheme a great financial success. Let them adopt the policy of the Brighton Corporation, where a man who used the full capacity of light for four hours was charged only 3d. per unit. He did not know whether they could get gas equal to 3d. per unit. In conclusion, he advised them not to let the chance go by of acquiring for themselves the power of supplying what was the necessity of the day—electric lighting. Mr. R. S. Lindley, who seconded the motion, said a great deal of doubt was expressed as to the possibility of revenue from electric lighting. He thought that doubt ought to be removed by the mere fact that, firstly there were several private contractors ready the moment they allowed their time to slip to come in and take up the lighting of the town. They would not do it if they did not see the prospect of a revenue in it. Moreover, they would require a higher profit than the Corporation would require a revenue, because they would have to pay interest to shareholders. If the Corporation accomplished the work themselves, the revenue they would get would go directly to repaying the expenses. He quoted the case of Manchester, which supplied its own current. There they had gone in for a total expenditure of £175 000 for their electric light, and in the second year of its working they had a revenue of 12 per cent., after writing off for depreciation, sinking fund, etc., a sum of £7,500. He thought that a great encouragement for Swansea to go ahead. After a protracted discussion, the electric lighting scheme was adopted by a majority of one.

Eccles.—The last proceedings of the Town Hall, Tramways, and Electric Lighting Committee of the Town Council stated that at a meeting of the committee held on the 1st inst. tenders were submitted for the carrying out of the various works comprised in the scheme prepared by Mr. S. V. Clirehugh for electric lighting in the borough, providing for the lighting of the whole of the street lamps, which were at present lighted by gas, and for such an amount of private lighting as the committee considered at present advisable, and fulfilling the obligations which the Council

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were under pursuant to their electric lighting provisional order. The tenders were of amounts which showed that the whole of the works, including buildings, etc., and adding 10 per cent. for legal charges and contingencies, could be carried out for the sum of £18,761, or £210 under the engineer's estimate, which was £18 971. The committee resolved that the Council should be recommended to accept the tender of the Manchester Edison-Swan Company, Limited, at the sum of £13 792, subject to the Local Government Board granting to the Council borrowing powers adequate for the carrying out of the whole scheme of electric lighting A further resolution of the committee recommended that application be made to the Local Government Board for power to borrow £20,000 for the purposes of the electric lighting scheme. Upon the motion by Alderman Kendall for the adoption of the report, Mr. F. Smith moved as an amendment that the acceptance of the tender be deferred. He said there would certainly be five members of the Council who would not return after November, as they did not intend to seek re election, and the matter of the electric lighting of the borough was one of such magnitude that it should be deferred until the new Council—who would have the carrying out of the work and who would be responsible for it—were elected. Alderman Kendall said he was rather astonished at the force of the opposition. There was no desire for unseemly haste on the part of the committee. With regard to the outside opposition that had been referred to, people had been told that the introduction of the electric light would mean an addition of 3d. in the pound on the rates. They were at first told that it would be 1s., but it had come down to 3d. It was to be remembered that the street-lighting with gas cost 4d. in the pound, and that, of course, would not have to be paid if they used electricity. The engineer would light the streets with electricity for the same price as gas. He thought the introduction of electric lighting would be a perfectly safe matter financially. There was, indeed, a company who were prepared, if the Corporation carried out the work, to run the light, paying depreciation, sinking fund, interest or whatever they liked, if they might be allowed to have the balance. It was to be remembered also, that they were at the present time getting their gas from a neighbouring borough. The Local Government Board would not grant them a further extension of their order. If the recommendations of the committee were rejected, the responsibility would not lie with the committee. The amendment was, however, ultimately carried.

Runcorn.—In accordance with notice given, Dr. Gastaldi moved at the Urban District Council meeting that it is in the interest of the ratepayers of Runcorn that electric lighting be introduced in the town and that a committee be appointed to carefully consider the subject. He said Staffordshire in that direction was well abreast of the times, and the Corporation electric supply of Stafford was already inaugurated, and that of Walsall coincided with it. A more remarkable portent of the times was that the small county town of Cheadle and the still more remote district of Alsager, on the northern boundary of the county, had a scheme under consideration, whilst the Rugeley Urban Council had announced their intention of taking into consideration the lighting of their streets with electricity. If places second in importance to Runcorn considered that electric lighting would be a boon to them, why should not Runcorn consider the question in the interest of the ratepayers? His reasons for its introduction were (1) that the town would be better lighted than at present; (2) that the town lent itself in a remarkable manner to provide electricity; (3) that in the ultimate end it would be the cheapest light; (4) that it would be a source of great revenue to the ratepayers. No one could gainsay his assertion that the town would be better lighted. During July and August, no gaslight was used no matter how dark the night might be, and the inconvenience was greatly felt by the ratepayers, who paid dearly for light they did not receive That anomaly would be absolutely removed if they adopted the electric light, because it would be the property of the town. With regard to his second point, as to Runcorn lending itself to provide electricity, he might say that at the waterworks they had got three boilers capable of producing any quantity of steam for the purpose of generating the motive power, capable of revolving the most powerful dynamos. They had there ample space for placing the necessary machinery to distribute electricity. Further, the Council was at the present time studying how to get rid of the nightsoil on account of the great cost involved in disposing of it, and the question of providing a destructor had occurred often to them. The difficulty would have to be met, and his idea was that if a destructor was erected it would provide nearly sufficient fuel to provide the motor power for the dynamo, and thus generate the light of the town out of the town's refuse. Then they had water near them—the Vyrnwy (Liverpool) supply—from which they could purchase additional power, which with the destructor would produce a powerful motor for the supply of electricity. In support of the third argument he would urge the dearness of gas. They paid now for the lighting of the streets nearly £900 a year. If they capitalised that amount it would give them, at 3 per cent., £30,000 of borrowed capital, and with that amount they could easily put up all the needed machinery and plant, and supposing that in 30 years they repaid the borrowed capital by a sinking fund, in 30 years the electric light would be a source of great revenue to the town as they would cease to pay rates for the lighting of the public streets, and have the revenue from private consumers to go to the lessening of the rates. He asked them to consider the question, and for that purpose to appoint a committee to go into the matter carefully and carry on investigations on all points. Mr. R. A. Posnett seconded the resolution. After a long discussion, in which several of the members, suggested on the committee, declined to be put on, the committee as suggested by Dr. Gastaldi was ultimately appointed.

Brighton.—A correspondent writes: "In the long debate that took place in the Brighton Town Council with regard to the request made by the Brighton and Rottingdean Seashore Electric Tramroad Company for permission to erect 13 steel poles on the foreshore between Paston-place and the eastern boundary of the borough, there was a general misunderstanding on one point that is well worth clearing up. Practically the debate turned on the advisability of conveying an electric current by underground or overhead wires, the comparative cost of the two methods, and their different effects on the amenities of the Front. If it were only a matter of conveying an electric current from one place to another no one doubts that it should, if possible, be done by underground wires, and, as a matter of fact, the difference in the cost would not be material. Considering the cost of the steel poles the underground method might possibly be even cheaper. But the electric cars are to be worked on the trolley system. The Board of Trade have given their approval to this, and without the slightest hesitation granted the company power to put up these poles in so much of the foreshore as is within their jurisdiction. If, therefore, the Corporation refuse to allow this overhead wire within the borough, the company will have to change the system when they come to the borough boundary. This means the carriage all the way of at least five tons of accumulators, simply in order to get over the half mile in Brighton, and as a matter of fact, no tramway worked with accumulators has yet been a commercial success. As to any danger from the wire, the Board of Trade have satisfied themselves on that point. Twenty-one feet above the highest tides is the height for the wire sanctioned by the Board of Trade, but the company have left it to the borough surveyor to determine the height he thinks necessary to let the Brighton boats go under. The poles would run along the side of the tramroad simply at such a distance therefrom as would prevent any foolish passenger from reaching them with a stick or umbrella—that is, roughly, they would be from 100 to 400 yards at sea south of high water mark. Practically the poles would be very similar to the standards at present being erected on the Marine-parade, only without the ornamentation; and, considering the distance of all the houses from the edge of the cliff, it is urged that they could hardly be an obstruction or eyesore in any way, as it is impossible to see the line at all from the windows of the reception rooms of the houses in this part of the town. It is hoped that on the matter again coming before the Council no further obstacle will be placed in the way of the completion of a most interesting undertaking—one calculated to attract still more attention to the eastern part of Brighton." At a meeting of the Lighting Committee the town clerk reported that he had arranged with the Brighton and Hove General Gas Company to continue the lighting of the streets proposed to be lighted by electricity in the borough until such time as the electric lamps are ready for use. Having regard to the introduction of electricity cables within the Town Hall to provide the motive power for the passenger-lift, the General Purposes Committee recommend that the electric light should be used in the town clerk's temporary offices now being erected in the assembly-room at the hall.

Oxford.—The Streets, Roads, and Lighting Committee of the City Council reported that they had received the following proposal from Mr. McLean, managing engineer of the Oxford Electric Company, Limited: "I have pleasure in submitting further amended schemes for the electric lighting of the principal streets of the city. Plan C shows the 32 lamps divided up as follows: eight all-night arc lamps placed at the following spots—opposite Beaumont-street and St. Giles-street; the junction of Broad-street and Cornmarket-street, Carfax; corner of St. Ebbe's-street and Queen-street; corner of Turl-street and High-street; opposite Catherine-street in High-street; opposite Queen's-lane in High-street; corner of Longwall in High-street. All these lamps are in existence with the exception of the last two named. The remaining 24 lamps, the positions of which are indicated on the plan, to be lighted three-quarters of an hour after sunset as at present, and extinguished at 12 midnight. On each of these 24 lamp-posts, a double bracket would be placed about half-way up, each bracket carrying a 32-c.p. incandescent lamp, which would be lighted at midnight and turned off at daylight. This arrangement would cost you £688, made up as follows: £26 each for all-night lamp, and £20 for each combination lamp. Should you, however, consider two lamps of 16 c.p. each would be sufficient for the 24 combination lamps, the cost to you would be £652. This is on the basis of 24 lamps at £18 10s. each. Instead of a two-light incandescent bracket, a single one could be substituted, if you preferred it, with equal candle-powers as above. The points in favour of either of these schemes over those previously submitted, and over the present system, are as follows: the half-night arc lamps are burned till midnight, instead of being extinguished at 11·45 p.m., as at present, and on each post incandescent lamps are supplied all night, affording ample light for the traffic after midnight, the eight arc lamps being reserved only at the principal corners." The committee recommended that the proposal therein contained be accepted, using the lamps of 16 c.p. for the 24 combination lamps, making the total annual cost £652; and that a contract be entered into for this purpose for a term of six years, determinable at the end of the first three, then at the option of the Corporation. Mr Kingerlee said they had given the gas company every opportunity of lighting the streets of the city, and he thought the experiment that had been tried in Beaumont-street was a very successful one, and it had been carried out at a very small cost. The electric

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company had also offered them certain advantages in the matter of lighting, and, with the 16 lamps that they had set up, the city got 30 times the amount of light they used to have from the gas lamps. Now the company offered them further facilities, and they proposed to increase the number of lights to 32, and to increase the power of the present lights from 1,200 c.p. to 2,000 c p. each. The old gas lamps had not been removed, and the cost of keeping them in repair amounted to £27. 13s. 5d. per year, and he proposed that the report of the committee be confirmed. The committee had a balance to the good of over £60 on the estimate for the half-year's lighting. Alderman Buckell said the city was interested in getting the best light it could, whether it be gas or electric light. The electric company had made proposals for extending their system and of increasing the present power of the light at a comparatively small cost, but at the expense to themselves of some thousands of pounds. He urged that both the gas company and the electric company should be allowed to do the best they possibly could. The citizens would have more than double the amount of light at less than half the cost of the present system. The report was adopted.

Marylebone.—Mr. T. H. Brooke Hitching, a member of the Marylebone Vestry, has printed a pamphlet entitled "Cheap Electric Light for Marylebone," from which we extract the following: No stranger traversing the streets of Marylebone on a winter evening, and observing the dull flicker of the public gas lamps, would believe that Marylebone is one of the wealthiest and most aristocratic parishes in London. Marylebone, with its 63 miles of public streets, its £1,500,000 ratable value, and its 140,000 inhabitants—largely of the upper and middle classes—is publicly lighted in a manner inferior to many small provinclal towns. Several of its principal shopkeepers—and Marylebone contains some of the largest shops or stores in the world—find it necessary to supplement the public gas lamps with outdoor electric lights, supplying the current at their own cost. The semi-darkness of the present lighting system is a reflection on the greatest capital of the world, and is calling forth caustic comments in the daily newspapers, which ask why the rich West-end parishes are so miserably and inadequately lighted; and do not hesitate to charge the West-end vestries with a lack of proper public spirit. In some instances the Press even advocate that the public lighting of the Metropolis should be under the direction and control of that already overworked body—the London County Council. The problem of efficient public lighting on the most economical basis is, however, now engaging the attention of a large number of our municipal corporations, vestries, and urban district councils. Since the proved success and high efficiency of electricity as an illuminant have been so largely demonstrated, many local authorities have decided to establish their own electric light stations, not only for the purpose of street-lighting, but also for the purpose of supplying the public with the light at reasonable but remunerative prices. London is considerably behind the provinces in respect of municipal undertakings, probably because Londoners have had no experience of the great advantages—pecuniary and otherwise—of municipal ownership of gas and water undertakings. Within the county of London, St. Pancras and Hampstead are the only parishes possessing municipal electric light stations. Shoreditch and Islington are, however, rapidly following suit, and other vestries have the question under consideration; but so far nearly all the electric light supply in the Metropolis is in the hands of limited liability companies. It is urged by some persons that electric light costs more than gaslight per candle-power, but this assertion is easily refuted when one takes into consideration all the advantages of electricity—the ease with which the consumption is controlled, together with its cleanliness and safety; and the refutation is confirmed by the very general adoption of the light by the largest commercial houses. With present appliances it may be generally accepted that electric light at 6d. per Board of Trade unit is equal to gas at 3s. per thousand feet The gas monopolies are already feeling the competition, and more economical gas-burners are being placed on the market. The increased cost of these, however, and their constant need of renewal make their acquisition of doubtful value from a pecuniary point of view. For the purposes of private lighting the Metropolitan Electric Supply Company have at present a monopoly in the parish of Marylebone, and this company appears to do its work in a manner fairly satisfactory to its customers. Notwithstanding its immense capitalisation—£500,000—and its heavy expenses as a public company, with its directors' fees, salaries, insurance, office and legal expenses, the Metropolitan Electric Supply Company is in a very prosperous position. It has a revenue of 8s. 5d. per lamp on no fewer than 209,000 lamps, making a gross profit in 1894 of £30,078 or nearly 5 per cent. A large portion of this profit is derived from Marylebone ratepayers. The charge per Board of Trade unit is 7½d. The revenue has regularly increased, and at present (September 21, 1895) the £10 shares of the Metropolitan Supply Company are quoted at £12. 5s. to £12 15s., whilst the £10 founders' shares are quoted at £270 to £300 each! The metropolitan parish of St. Pancras, which does its own public lighting, supplies electricity to the public at about 5½d. per Board of Trade unit, and owing to the excellent municipal management the electric lighting makes a profit of no less than 7 per cent. per annum. The generation of electricity should only be in the hands of the local authorities, which can manufacture and supply more cheaply by far than any limited liability company; the local authority has a staff at hand for collecting the accounts, and it would then more effectively control the taking up of public streets and roadways than is the case with the supply in private hands. Shoreditch is not a wealthy parish of the Metropolis, but it has many "practical" gentlemen on its Vestry Board. Shoreditch is now lighted with gas, but the Vestry has decided to establish an electric light station. A suitable site has been acquired, on which is to be erected a station with the latest improvements in electrical engineering. This will cost £4,000. A range of four tubular boilers will generate sufficient steam to work three electric generators of a capacity of 150 kilowatts each, one of 50 kilowatts, and two of 15 kilowatts, and three arc light generators of 20 kilowatts. Cost, £24,000. Two sub-stations and complete apparatus will add £7,400 more. A dust destructor, or in this case a dust utiliser, with 14 furnaces and boiler-house complete, will cost the parish £8,000. The mains, conductors, conduits, arc lamps, etc., about £20,000 more. In all some £63,000. The advising engineers to Shoreditch Vestry (Messrs. Kincaid, Waller, and Manville) estimate that the plant specified above will be capable of supplying current for 15,000 lamps. These, at a charge to the public of 6d. per unit, they estimate will yield £7,500 per annum. The engineers also estimate that the utilisation of the dust for fuel will generate all the steam necessary for producing the electricity, and will, in addition, supply the baths and wash-houses with hot water and steam—an annual saving to that department of no less than £500 The Vestry now pays some 3s. per ton for the disposal of its 20,000 tons of dust—each year £3,000. The engineers estimate the cost of destroying this refuse at £1,000 for wages—with £250 for repairs £1 250, a further saving to the Shoreditch ratepayers of £1,750 per annum. Prof. Forbes several years ago advised Paddington Vestry to utilise its dust for the purpose of generating steam for electricity, so the idea has no novelty. It rests, however, in the county of London on the East-end parish of Shoreditch to prove its efficiency and economy. Dr. Robinson, clerk to the Shoreditch Vestry, estimates that in 42 years the parish will not only pay off its debt on the electric light undertaking, but will, in addition, possess an asset worth, with goodwill, not less than £100,000 even if no extension takes place. He adds: "If, however, the more favourable view of the case be taken, and the extensions which the engineers anticipate are realised, involving a proportionately greater profit at comparatively little increased expense, the proposed undertaking assumes very large proportions, and offers such magnificent profits that it would, in my opinion, soon compare favourably with the most successful gas or water monopolies." The Liverpool Corporation is so impressed with the desirability of possessing the electric light supply of the city that it has recently purchased the plant and generating station of the limited company which has hitherto sold the light to the citizens. In Marylebone the cost of carting and disposing of the dust for one year, 1894 5, was £7,300, including collection. This work is done by contract. The cost of lighting the parish, 3,640 lamps, was £10,215, and maintenance £756, together £10,971. The cost of fuel to the Baths Commissioners for the last complete year was £597. These figures involve large payments out of the rates, payments which would probably be much reduced by a more progressively practical management. An opportunity now presents itself for Marylebone to be the pioneer among West-end corporate bodies of the county of London, in the establishment and maintenance of a municipal electric lighting station—a station which could not only light the streets of Marylebone in a manner befitting the wealth and importance of the parish, but would supply to the Marylebone ratepayers the best of all illuminants at a cost lower than that of gas. Better lighted streets mean to the residents greater safety; to the tradespeople better business; and to the parish greater prosperity. In the production of this light the dust and refuse of the parish might be destroyed, without emitting disagreeable fumes, and at a saving probably of £5,000 per annum. And ultimately, when electricity becomes the universal artificial illuminant, a large profit will accrue to the parish, which will have the effect of reducing the burdens of the ratepayers so far as the purely local rates are concerned. This course, if adopted, will break down the gas monopoly—which takes from Marylebone very many thousands of pounds per annum—and will create the first profit-bearing municipal undertaking in Marylebone, and fit it to rank as a corporation with Birmingham, Manchester, and the other chief municipalities of the kingdom. On July 18, 1895, the Marylebone Vestry, on my motion, resolved, "That it be referred to a special committee to be appointed to consider and report as to the desirability of lighting the parish by means of electricity, and as to the desirability of the Vestry undertaking the work, and that the committee be empowered to make the fullest preliminary enquiries of those metropolitan vestries which have adopted this course" The members chosen are Mr. Curry, Mr. Emery, Mr. Hopkins, and the writer—Mr. T. H. Brooke Hitching.

PROVISIONAL PATENTS, 1895.

SEPTEMBER 23.

17734. **A new or improved electrical alarm and connections therefor.** Henry Landergan and Gerald Cuthbert Grahame, 63, Clapham-road, London.

17741. **A new or improved device for indicating the duration of telephonic conversations.** Romain Van Kerckhove, Norfolk House, Norfolk-street, London.

17745. **Improvements in or relating to electrolytic cells.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Carl Hoepfner, Germany.)

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SEPTEMBER 24.

17758. **An improved automatic electrical cut-out.** Martin Edward Crowne and Henri Charles Fowler, 11, Furnival-street, Holborn, London.

17773. **An improvement in telephone fittings.** Edward Morris Edelsten, 10, St. George's-crescent, Liverpool.

17782. **The adjustable electric dial contact.** George Wall, 10, Nairn-street, Poplar, London.

17788. **Improvements in electromotors.** Dugald Clerk, 18, Southampton-buildings, Chancery-lane, London. (Howard Lacy, Louis F. Johnson, and Walter J. Slacke, United States.) (Complete specification.)

17790. **Improvements in electromagnets and method of winding the same.** Dugald Clerk, 18, Southampton-buildings, Chancery-lane, London. (Howard Lacy, Louis F. Johnson, and Walter J. Slacke, United States.) (Complete specification.)

17791. **Improvements in dynamos.** Dugald Clerk, 18, Southampton-buildings, Chancery-lane, London. (Howard Lacy, Louis F. Johnson, and Walter J. Slacke, United States.) (Complete specification.)

17821. **Improvements in or connected with secondary batteries.** Frank King, 47, Lincoln's-inn-fields, London.

17830. **Improvements in and relating to mechanism for electrically indicating the extinction of lamps and for analogous purposes.** Henry Harris Lake, 45, Southampton-buildings. Chancery-lane, London. (Horace See, United States.) (Complete specification.)

17864. **Improvements in or relating to electric indicators or annunciators.** John William Hall, 323, High Holborn, London.

17871. **Improvements in compositions for protecting ships' bottoms against fouling, preserving wood, and shielding submarine electric cables from penetration by torpedo worms.** William Livingston Gunn, Lloyd's Bank-buildings, Bristol.

SEPTEMBER 25.

17918. **Improvements in the manufacture of incandescent electric or glow lamp.** Percy Head Baily, 62, Darnley-road, Hackney, London.

17919. **Improvements relating to telegraph and like poles.** Frank Everett Garner and Charles Robinson Bliss, 55, Chancery-lane, London.

17921. **Improvements in the manufacture and production of filaments for incandescent electric lamps.** Joseph Wilson Swan, 47, Lincoln's-inn-fields, London.

17924. **Electric smoke annihilator.** Richard William Hill, 97, Newgate street, London.

17925. **Production of carbonate of soda and chlorine gas by electricity.** Richard William Hill, 97, Newgate-street, London.

SEPTEMBER 26.

18018. **Improvements in incandescence electric and gas lamps and lanterns.** Vittorio Croizat, 28, Southampton buildings, Chancery-lane, London.

18033. **Improvements in or relating to developing displaced magnetic phases and producing rotary magnetic fields.** William Phillips Thompson, 6, Lord-street, Liverpool. (Charles Schenck Bradley, United States.) (Complete specification.)

18034. **Improvements in oxidising lead and lead compounds for the construction of electrical accumulators.** Henry Leitner, 31, High Holborn, London. (Complete specification.)

18036. **An improved process for the preparation of electrodes for primary, secondary, and dry batteries.** Henry Leitner and Emanuel Reicher, 31, High Holborn, London. (Complete specification.)

18038. **Improvements in and appertaining to electrodes.** Henry Leitner and Emanuel Reicher, 31, High Holborn, London. (Complete specification.)

SEPTEMBER 27.

18065. **Improvements in the method of and means for electrically illuminating block dials and signs.** John Haynes and Herbert Hampton Hall, 57, Barton-arcade, Manchester.

SEPTEMBER 28.

18152. **Improvements in telephones.** Rudolf Goldlust, 19, Southampton-buildings, Chancery-lane, London.

SEPTEMBER 30.

18200. **Improvements in connection with arc lamps more particularly adapted for electric searchlights.** Frank Michael Lewis, 2, East-parade, Leeds.

18226. **Improvements in secondary batteries.** Carl Fisker and Louis Bertram, 1, Broad-street-buildings, Liverpool-street, London.

18236. **Improvements in or connected with electric burglar and other alarms.** Thomas Alfred Clarke, 6, Lord-street, Liverpool.

OCTOBER 1.

18305. **Improvements in means of supporting and insulating electric conductors within culverts or like conduits.** Rookes Evelyn Bell Crompton, 55, Chancery-lane, London.

18369. **Improvements in electric locomotives.** Jean Emile Amen, 65, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1891.

19965. **Electric conduits.** Love. (Second edition.)

1893.

24867. **Electric railways.** Love and Wheeler. (Second edition.

1894.

4366. **Dynamo-electric machines.** Boult. (Compagnie de L'Industrie Electrique. (Reprint with alterations.)

13422. **Electric relays.** Thompson. (Maréchal and others.)

14850. **Electric lamps.** Langhans.

16687. **Electric bells.** Vogt.

20432. **Electric bell for mines, etc.** Allsop.

20442. **Arc lamps.** Gwynne and Kennedy.

21140. **Controlling electrical illumination.** Siemen Bros. and Co., Limited. (Siemens and Halske.)

21141. **Electromotors.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

21439. **Electrical sewer ventilator.** Lacey.

21446. **Electric meters.** Barley.

21555. **Secondary batteries.** Timmis.

21613. **Telephones.** Parker.

21821. **Dynamo-electric machines, etc.** Thomas Parker, Limited, and Parker.

21822. **Electrolytic separation and alloying of metals.** Newburn. (Hornig and another.)

1895.

3679. **Arc lamps.** Foster.

3903. **Electrical conductors.** Fitzpatrick. (Electric Bell and Resistance Company.)

11864. **Plate for electric accumulators, etc.** Ribbe.

13205. **Telegraphic signalling.** Pupin.

14337. **Electric fire alarms.** Bakker.

14792. **Arc lamps.** Rogers Arc Lamp Co., Limited, and Rogers.

14801. **Electrolytic production of oxides and salts.** Luckow.

14842. **Electric condensers.** Thompson. (Bradley.)

14937. **Electric block signals for railroads.** Gordon.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6¼
Brush Company, Ordinary	3	1⅛-1⅜
—— Non. Cum., 6 per cent. Pref.	2	2-2¼
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5⅛-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6¾-7¼
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	13½-14½
—— 6 per cent. Cumulative Pref.	10	14½-15½
—— 5 per cent. Debenture Stock	100	133-137
City and South London Railway, Consolidated Ordinary	100	38-40
—— 4 per cent. Debenture Stock	100	134-136
—— 5 per cent. Pref. Shares	10	14½-15½
County of London and Brush Provincial Co., Ordinary	10	8½-9¼
—— 6 per cent. Cum. Pref.	6	8½-9¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1½-2
Edison and Swan United Ordinary	3	1⅞-2⅛
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅜-⅞
—— 6 per cent. Debentures	—	95-100
—— 7 per cent. Cumulative Pref.	2	2-2⅛xd
Elmore's Copper Depositing	2	⅞-1
Elmore's Wire Company	2	1-1⅛
Fowler-Waring Cables	5	⅞-1
W. T. Henley's Telegraph Works, Ordinary	10	13¾-14
—— 7 per cent. Preference	10	15½-16½xd
—— 4½ per cent. Debentures	100	106-108
House-to-House Company, Ordinary	5	4-4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	19-21
—— 4½ per cent. Debentures	100	100-102xd
Kensington and Knightsbridge Ordinary	5	8-8½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅞-8⅛
Liverpool Overhead Railway	10	11½-12½
—— 5 per cent. Pref.	10	15-15½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric Supply	5	¾-1
Metropolitan Electric Supply	10	11½-12
—— 4½ per cent. First Mortgage Debenture Stock	100	117-119
National Telephone, Ordinary	5	6½-6⅝
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Non. Cum. Third Pref.	5	6½-6¾
—— 3½ per cent. Deb. Stock	100	106-108
Notting Hill Company	10	8½-9½
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	5	7½-7⅞
—— £4½ shares	4½	6-6¼
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-105xd
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8½-8¾
—— 7 per cent. Pref.	5	9-9½
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4⅛-4¼
Westminster Electric Supply, Ordinary	5	8½-9
Yorkshire House-to-House	5	6¼-7

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NOTES.

Writer's Cramp Cured by Electricity.—The New York *Medical Journal* reports the cure of a case of writer's cramp in a telegraph operator by applications of static electricity.

The Physical Society.—At the meeting of this society on October 25 the following papers will be read: (1) "The Radial Cursor," by Mr. F. W. Lanchester; (2) "The Development of Arbitrary Functions," by Prof. Perry and Mr. Hunt.

Electric Hearses.—An electric tramway has been laid from the Cimitero Monumentale, Milan, to the new burying-ground at Musocco. A special black hearse-car serves for the transport of the corpse. The mourners follow in a passenger car.

Accumulator Patent Dispute.—The Berlin High Court has dismissed, with costs, the appeal of the Akkumulatorenfabrik A.-G., of Hagen, against the decision with reference to the form of accumulator manufactured in Berlin by A. Boese and Co.

Obituary.—Ingenieur und Geh. Kommerzienrath Eugen Langen, who died recently, was not, as has been stated in some papers, a member of the firm of Felten and Guilleaume. He was, however, one of the directors of the Elektrizitäts-Gesellschaft Schuckert, the Hörder Bergwerks-Verein, the Gasmotorenfabrik Deutz, etc.

Visiting the States.—The president of the Tramways Institute of Great Britain and Ireland, Mr. W. J. Carruthers Wain, C.E., is again visiting the United States and Canada on a mission of further enquiry into the question of electric traction, and to that end he will personally inspect all the newest and improved methods of traction in the United States.

Telephonic Communication between Belgium and Germany.—On Tuesday, Belgium and Germany were placed in direct telephonic communication with each other. Antwerp and Cologne are the extreme points between which conversation can be carried on, and the price for three minutes' use of the line varies from 1·25c. to 2f., according to the distance.

The First Electric Railway in Mexico is soon to be in operation in the State of Vera Cruz. It will run from the city to Orizaba, a distance of about 90 miles. The construction of the line is now in progress. It will pass through Coatepec, Jico, and other towns in the rich coffee district of the State. General Frisbee is the owner of the concession for the railway.

African Chiefs and Electricity. — It will be remembered that Nasrulla Khan was very much impressed by the generating apparatus of the Liverpool Overhead Railway. A similar experience has befallen the three African chiefs Khama, Sebele, and Bathamen during their visit to the northern city; indeed, they were so struck with the power and genius of the engineer, Mr. Cotterill, that they incontinently dubbed him, and afterwards persistently referred to him as, "the King of Lightning."

France and Submarine Cables.—The *Débats* again warns Parisians against the risk which France runs in time of war in permitting England to possess a monopoly of the submarine cables. France, it says, must at all costs be made independent of England in this respect. The present it considers a favourable opportunity for doing so. On all sides a final effort is being made to throw off the "English yoke." Japan and the United States, the journal adds, are extending their hold over the cable system, one of the French companies is showing renewed enterprise, whilst the Minister of Commerce declared at Calais the other day that he would soon give the cable company there some work to do.

The Electric Incubator, upon which Herr Otto Schulze, of Strasburg, has been at work for three years, is intended to overcome the ordinary difficulties of artificial hatching of chickens. The apparatus, it is said, is easily manipulated, and requires only an uninterrupted but small supply of electricity. Automatic attachments regulate both temperature and moisture, the former being kept within one-tenth of a degree of the normal temperature of incubation. In this apparatus 90 in every 100 eggs are expected to hatch. An electric mother, a box in which the freshly-hatched chicks can find heat and protection, while being at liberty to run about on the ground when they choose, has been devised as an accompaniment of the incubator.

Novel Use of the Searchlight—The searchlight has recently been put to a rather suggestive use at Stalybridge, at Messrs. Gartside's works, where there is a strike, in connection with which rioting has taken place. The light has been used "with the idea of preventing the striker from maliciously setting fire to the temporary sheds erected for the protection of the men at present employed.' It is now being used nightly, in conjunction with the police force established at the works, to search the surrounding country and to illuminate the various parts where pickets are placed. It is said that the arrangement enables the services of a number of policemen to be dispensed with. The light used is one of Messrs. Baxendale and Co.'s "Ship Canal" class.

Now Antilles Cables.—The Spanish journal *El Heraldo* says that the Colonial Minister has signed a contract with an English firm, the Cuba Submarine Company, for the laying of cables connecting Cienfuegos with Las Tunas, Júcaro, Santa Cruz, and Manzanillo, so that Habana may be in telegraphic communication with the whole of the southern coast of the island of Cuba. The concession is to be valid until August, 1910. The amount agreed upon for the work is 10,500 pesos annually, payable in Cuba in monthly instalments during the 14 years. The cables were required to be laid by January next, and it is expected that the company will have them down during December. The tariff for dispatches will be in accordance with the rates at present ruling, but there will be a reduction of 50 per cent. to Government officials.

Spanish Ship Wiring.—A Spanish man-of-war has has been run down at Havana with great loss of life. After the collision became inevitable, and in the excitement and rush, "a fireman stumbled against the electric wires supplying light and displaced them, and in an instant total darkness enveloped the ship. Under such circumstances the ship was doomed." We should think, remarks a New York contemporary, from whom we quote, that it would be. The wiring of a man-of-war which at a critical moment can be kicked asunder by a clumsy fireman would certainly cause or intensify a calamity sooner or later. We wish, the journal adds, that we could persuade ourselves that such abominable work were confined to Spanish ships of war—but we can't. The opportunities for improvement in all electrical work afloat are very numerous and extensive.

Kapp on Double Voltage.—Mr.-Herr Kapp has a leader on the subject of the increased pressure at St. Pancras in the latest number of his journal, the *Elektrotechnische Zeitschrift*. He comes to the conclusion that

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"the doubling of the voltage in existing three-wire systems presents no difficulty, for with the excellently-insulated cables which are used in Germany 200 volts are not more dangerous than 100 volts. The same may in most cases be said also of the lamp switches and safety devices, so that the general introduction of the double pressure, and with this the possibility of a distribution far beyond present limits, depends simply and solely upon the question whether it will be possible to produce really reliable and economical lamps for 200 volts. This is a question whose answer must be left to the future. We shall, however, soon have, at any rate, a partial solution of the problem from the experiences in St. Pancras"—and Bradford!

The Magnetisation of Iron.—Prof. K. Zickler, of Brünn, has a lengthy article with this title in the October number of the *Zeitschrift für Elektrotechnik*. He says that among the magnetisation curves resulting from the various forms of electromagnets, those which are known as normal magnetisation curves have in the last few years become of great practical importance, since they are used as the basis for the calculation of magnetic circuits. He refers by way of example to the process of Messrs. J. and E. Hopkinson for estimating the magnet winding in dynamos. Owing to its use in the solution of practical problems, the study of the laws governing these normal curves has assumed a particular importance. Prof. Zickler has been investigating the subject for some little time, and he has succeeded, with an approximation sufficient for practical purposes, in ascertaining these curves in their whole extent, both calculably and constructively, when the co-ordinates of an accurately fixed point of the curves are given.

Thermodynamics.—At the City and Guilds Technical College, Finsbury, Leonard-street, City-road, E.C., a special course of four lectures on the principles of thermodynamics and their application in engineering will be delivered by Prof. John Perry, M.E., D.Sc., F.R.S., on alternate Thursday evenings, from 7.30 to 9 o'clock, commencing on Thursday, October 24. Students are supposed to be already possessed of some knowledge of heat and thermodynamics, and also of the differential calculus. I. October 24.—How we calculate exactly the heat and work changes when any changes of volume pressure or temperature occur in stuff subjected only to fluid pressure. II. November 7.—The first and second laws of thermodynamics. III. November 21.—Application to air-engines and especially to gas-engines; also to compressors, exhausters, and refrigerators. IV. December 5.—Application to the steam-engine. One or more additional lectures may be necessary, and, if so, their dates will be announced later. The fee for the course is 4s.

The Measurement of High Temperatures.—Mr. J. McCrae describes in *Ann. Phys. Chem.* a small thermo-electric element which he uses for the determination of temperatures varying from 300deg. to 1,400deg. It consists of a junction of platinum and platinorhodium, and the author states that between the above limits the E.M.F. is approximately proportional to the temperature. By its means the following melting points were determined:

	Deg.		Deg.
Sodium iodide	694·7	Strontium chloride...	853·7
Potassium iodide ...	722·7	Sodium carbonate ...	856·7
Potassium bromide...	745·5	Sodium sulphate ...	881·2
Sodium bromide.....	761·1	Potassium carbonate	887·5
Calcium chloride ...	802·1	Barium chloride.....	915·6
Potassium chloride...	803 9	Potassium sulphate..	1,058·9
Sodium chloride.....	811·0		

The boiling point of stannous chloride was found to be 603·25deg., whilst the temperatures of an alcohol flame and the blue point and the hottest part of a Bunsen burner flame were determined as 1,488deg, 1,542deg., and 1,725deg. respectively.

"Harnessing the Tides."—Now that the current of Niagara has been utilised for generating electricity, it is not surprising to find a writer in the *North American Review* insisting upon the old-new theory that we must "harness the tides." "The tides of the North and East rivers," he says, "produce power enough to generate all the electricity required to light New York and Brooklyn, to do all the mechanical work in the factories and machine shops, and to run all the railroad lines in the city and suburbs. . . . All that is required is to store this immense power, and to turn it to profitable use." If the tides would not give a constant supply of power, they would, it is argued, vary less than the inland rivers in summer-time, and generating plant suited to the purpose could no doubt be easily designed. The writer fears that unless New York, Brooklyn, and the neighbouring cities begin to utilise the water power at their doors the Niagara Falls Power Company will want to run an electrical conduit to New York. As "a conduit capable of bringing from 100,000 h.p. to 200,000 h.p. from Niagara would cost more than a four-track steam railway," he thinks the money required might more profitably be spent in New York itself, where the demand for electric power is increasing very rapidly.

Photography by Electric Light.—Mr. Moffat, an Edinburgh photographer, gave a demonstration in his studio recently, before a numerous audience, of a new system of photography by means of the incandescent electric light. The apparatus is the invention of a Mr. Adamson, of Glasgow. It consists essentially of a series of 20 incandescent lamps of 100 c.p. each strung round the inner edge of an umbrella-shaped frame which is covered with white silk. This umbrella is fastened by a universal joint to a beam like that of a steelyard which runs on rails suspended from the roof, and has also a universal joint, so that with a touch of the hand the light can be run from one end of the studio to the other, and adjusted at any angle. The light, it is stated, is under perfect control, and the switch is so arranged that the lamps can give any light up to 2,000 c.p. Mr. Moffat explained the manner in which the apparatus was worked, and several excellent negatives were taken. One of the drawbacks which made the arc light a failure in photography was, Mr. Moffat said, the harshness of contrast in the lights and shadows, but with the incandescent light this difficulty was overcome. In the negatives which were taken by way of demonstration the shadows, it was shown, could be further toned by adjusting silk screens between the light and the sitter. The finished specimens of electric light photographs which were on view were found to be as soft and delicate as any daylight photographs.

The Position of Telegraphists.—An Irish correspondent writes: "Discontent with the present condition of affairs, and the utterly hopeless prospect, has reached an acute stage in the telegraph service. Every steamer leaving Southampton for the Cape has on her passenger lists the names of operators from every important office in the Kingdom—the flower of the telegraph service—who, in sheer disgust, have thrown up their Government appointments and accepted lucrative and responsible offices in South Africa. Some years ago Cork contributed its quota to the tide, and now these gentlemen are urging their erstwhile colleagues to join them in the 'Dark' Continent. In response to a communication (which has not yet received official recognition), asking for a dozen men for service in South Africa, more than that number of Cork men alone are candidates; but their claims are hard pressed by the

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numerous applications from operators in London, Liverpool, Manchester, Glasgow, Limerick, Dublin, and other centres anxious to exchange badly paid British Government telegraphistships for remunerative salaries elsewhere. The avidity with which the telegraphists of the United Kingdom are snapping up foreign appointments throws rather a curious light on Mr. Arnold Morley's statement that those in the service are quite content with their lot, and will furnish useful data with which to confound that statement before the committee of enquiry into the telegraph and postal grievances." It is not often that an Irishman is found who denounces the alleged injustice suffered by a class of Englishmen.

"The Truth about Foyers."—A "special correspondent" of a Dundee paper has visited the Falls of Foyers, and duly chronicled the results of his observations and enquiries. He entitles his communication, "The Truth about Foyers: A Revolutionary Scheme of Progress." The district "has for more than a century been the joy of the tourist and the pride of the native," but a change has come over it. "For months blasting and dynamite have been the predominant factors of the situation, the roadways, swept by fragments of broken rock, afforded no security for sightseers, and the steamers—save an occasional one—have ceased to wait. . . . The crack of the mason's mallet mingles with the clang of the blacksmith's hammer, as workshops, dwelling-houses, sheds, and offices rear themselves from the base to the summit of the hill." We are told that "in future Foyers is to be celebrated not only for its magnificent falls, but for its gigantic aluminium works." It is added that "the time for staying this movement is past; the hands of the clock are too far round ever to go back. More than 400 workmen of all kinds are at work, and plant worth from £40,000 to £60,000 has been laid down." The correspondent was conducted over the works by a "courteous official," who, in reply to an enquiry as to the probable fate of the falls, said: "The engineers could probably tell you better than I can, but the scheme of the company is, I think, designed to improve the appearance of the falls—certainly to make the flow more uniform." So far so good.

Electric Clocks.—Mr. F. Hope-Jones, with whom was Mr. G. B. Bowell, delivered a lecture on Wednesday last at the British Institute of Horology, Northampton-square, E.C., on the subject of electric clocks. The lecturer described in detail, with diagrams, the system of the Synchronome Company, in which an electrically-driven pendulum controls a set of dials also driven electrically, the movement consisting essentially of an escapement driven by two pallets so linked together that one gains on the other, either circumferentially or radially, during a part of its cycle, in order to pass the dead centre. The energy is derived from an electromagnet and a dry cell, and it is an essential part of the system that the mechanical force driving the hands is transmitted by a pushing action through the points at which the electrical contact is made and broken. False or double contacts, which would set the dials wrong, are thus avoided. The duration of the contact is about one-fortieth of a second. For commercial purposes the whole of the dials are synchronised by the pendulum every quarter minute. For this purpose the set of dials are connected in series, and provision is made for regulating them all at once without stopping the pendulum; one dial, for instance, being arranged so that if it is set back all the others of the set are switched out and wait until it comes into synchronism with them, when the original connection is re-established. This system is available for all sizes short of turret clocks. A system for the latter was also described, in which a motor was used with a device for picking up losses due to a temporary failure of the motor. A discussion followed.

The Electro-Harmonic Society.—A smoking concert will be given by this society on Monday, October 21, at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., at eight o'clock. The artistes will be: The "Lyric" Vocal Quartette, Mr. Thomas Powell, Mr. Charles Strong, Mr. Etherington Smith, Mr. Horace Reynolds, Mr. Daniel Price; recitations, Mr. Ernest Meads; humorous sketches, Mr. George Schneider; silver bells, Mr. R. B. Hopkins; at the pianoforte, Mr. Sidney Hann. The musical directors are Messrs. T. E. Gatehouse and Alfred E. Izard. The following is the programme—Part I.: quartette, "Annie Laurie" (Anon), the Lyric Vocal Quartette; song, "Ailsa Mine" (Newton), Mr. Charles Strong; pianoforte solo, "Fantasie Impromptu" (Chopin), Mr. Sidney Hann; song, "Oh! Hear the Wild Winds Blow" (T. Mattei), Mr. Daniel Price; recitation, "Julius Cæsar," Act 3, Scene II., Antony's Oration (Shakespeare), Mr. Ernest Meads; silver bells, "The Holy City" (Adams), Mr. R B. Hopkins; song, "Stars of the Summer Night" (B. Tours), Mr. Etherington Smith; humorous sketch, Mr. George Schneider. Part II.: Plantation melody, "The Old Folks at Home" (specially arranged), the Lyric Vocal Quartette; song, "The Bedouin Love Song" (Pinsuti), Mr. Horace Reynolds; silver bells, "The Promise of Life" (Cowen), Mr. R. B. Hopkins; song, "Aubade" (Cowen), Mr. Thomas Powell; recitation, "How Mr. Smiggles Went to a Public Dinner" (Turner), Mr. Ernest Meads; song (Irish), "Biddy Aroo" (Maitland), Mr. Daniel Price; humorous sketch, Mr. George Schneider.

Horseless Carriages.—The description and illustration of the Jeantaud electric carriage, which appears on another page, will have peculiar interest in view of the exhibition of horseless carriages which was held on Tuesday on the showground of the Tunbridge Wells Agricultural Society, under the superintendence of Sir David Salomons. Two carriages driven by Daimler motors, a tricycle also propelled by a motor worked by petroleum spirit, and a "steam horse" were shown in operation. The "steam horse" was quite out of the running for honours. It gave forth a good deal of steam at times, was noisy, and dropped burning cinders. The two carriages were both from Paris. Complaint was made of the vibration set up in them. There were no electric road vehicles tried. Curiously enough, a paper has just been read before the Society of German Tramways and Light Railways Administrations (Verein deutscher Strassenbahn- und Kleinbahnverwaltungen) by Regierungsrath Köhler, of Berlin, in which the author unfavourably discussed the gas car or carriage. He holds the working cost of 18pfg. (2·16d.) the kilometre ($\frac{5}{8}$ mile) to be very high, and far exceeding that of the average horse tramway, and he laid stress on the drawbacks of the gas-car—the penetration of street-dust into the bearings and cylinders of the engine, the heavy vibration, smell of gas, and the impossibility of having the windows open on the weather-side of the car. Electrical working was, he said, much to be preferred. Again, during the trial run the other day of a tramcar fitted with a new oil-motor at Glasgow, the oil-tank was set on fire, and the car was burnt in the centre of the street. Forty passengers, mostly town councillors, left the car in safety.

The Electric Punkah Question has again been raised in India. A correspondent writes to *Indian Engineering*: "In last week's daily papers there is an account of a new electric punkah-pulling machine. In describing the apparatus we are informed that the inventor contends that, to get an efficient punkah-pulling machine, the punkah

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must give time to the machine and not the machine to the punkah. It is no new theory, for this was demonstrated in your journal over three years ago. There are over 120 patents for punkah pullers, and yet none have come into general use. The jerk seems to be the rock upon which most inventors get wrecked, and to obtain this some most extraordinary devices are resorted to. One of the simplest machines I have seen is Agabeg's puller. The inventor gets his jerk by the use of a flywheel on the shaft of the prime mover, and regulates the machine to suit the punkah by a sliding weight in the horizontal lever, to which the rope is attached. For a given punkah, once the weight is fixed it wants no more adjusting. I have seen one of these machines pull for hours without the variation of a single stroke, and the jerk is the same as that given by a coolie. The one I allude to was worked by a small Robinson hot-air engine of 4in. cylinder, and heated by a Vaguer stove. It took about 15 minutes to get up power and then ran eight hours, or until the oil in the reservoir was exhausted. This machine worked a 7ft. punkah, 24 strokes a minute with a 4ft. stroke. I also saw one of the same inventor's machines worked by electricity with the same excellent result." The correspondent adds that so long as the coolie is cheaper than the cost of working a machine puller, there is no chance of their ever coming into general use. He nevertheless thinks that, in a place like Calcutta, if electricity be laid on in the houses the same as gas is the machine "may get a look in."

Electricity in Mining Operations.—The advantages inherent in the electric explosion of mining charges will be generally recognised. It permits of an absolutely simultaneous explosion of several charges, which is always desirable from the point of view of the destructive effect produced, and at the same time it avoids the loss of time brought about by consecutive discharges, particularly when they have to take place in badly-ventilated workings, from which the smoke and gases produced by the explosion can only be cleared out very slowly. Besides, there is no danger from misfires, and the workings can be immediately approached without fear of the delayed explosion, which is always a possibility with powder fuses. Moreover, there need be no danger from firedamp, or from the act of firing the fuse. All these reasons, M. P. F. Chalon, writing in *L'Electricien* of October 5, thinks, will favour the use of electric fuses. Unfortunately, however, they are very expensive. In France wire fuses cost 300f. a thousand, and the discharging apparatus comes to 400f. or 500f. High-tension or spark dischargers are a little more economical, but it is not easy to determine previous to the explosion whether they are in perfect order, and it is necessary that the insulation of the conductors should be absolutely perfect. M. Chalon then goes on to describe a cheap American discharger, which he strongly recommends for adoption in fiery workings in French collieries. The discharger consists essentially of a magneto-electric machine driven by a rack and pinion, so that the action is very much like that of a garden hand-pump, an intermediate gear being provided to give the necessary speed. A discharger of sufficient size to produce 20 or 30 simultaneous explosions weighs 13 kilogrammes (about 28lb.), including the strong wooden case. It is designed to work with fulminate detonators up to a distance of about 500 yards. It is tested by connecting up to the terminals a small specially-constructed incandescent lamp. A separate apparatus is required to test the fuses and line. A current is sent through the line, not strong enough to heat the wires of the fuses, but sufficient to ring an electric bell if the circuit is in good order and complete. An arrangement is provided for adjusting the current to the number of fuses in circuit.

Advances in Electrotherapy. — The American Electrotherapeutic Association has just completed its fifth annual meeting. This year it met in Toronto, and while, Mr. J. Henderson writes, the attendance of members was not so great in the Canadian city as was expected, and the amount and value of the work done was not quite up to the standard set by the former meetings, yet many creditable papers were presented, and the discussions were lively and interesting. Five years ago electricity, as applied to medicine and surgery, was in a very chaotic condition. There was no uniformity in appliances or practice, no instruments for exact measurement, no facilities for obtaining the needed preparation for the practice of electrotherapeutics, no exact information regarding the appropriate use for the various forms of electrical energy in the treatment of disease. A radical change has been wrought in this state of things by this association. In the beginning, it promptly set itself about clearing the ground of chaff and rubbish, and developing a science of electrotherapeutics out of the solid facts which physics and physiology had to offer. Certain men, whose experience had taught them the value of electricity as an aid in checking the ravages of disease, had the courage of their convictions and did not hesitate to flood with the light of pure science their field of operation. Men eminent as electrical engineers and teachers of physics were invited to join them to aid in separating the sound from the unsound, the true from the false, in that which had been taught and practised as electrotherapeutics. By their aid a foundation of solid fact has been established, and charlatanism, which has long been in possession of this valuable territory, has begun to lose ground, and the claim of electricity, as a factor in therapeutics, has begun to receive respectful attention from medical educators and able practitioners the world over. The machinery through which this association has been able to effect this result in so short a time has been the establishment of standing committees composed of competent men, some practitioners of medicine or surgery, others not, whose duty it is to examine, test, and annually to report upon the mechanical construction, electric action, and efficiency, and the physiological and therapeutic effects of the various instruments designed and recommended for therapeutic work. The work of these committees continues the year round. Manufacturers have welcomed and aided their efforts, and the result has been a steady progress towards simplicity and uniformity in the appliances produced, and a greater unanimity in the results reached in practice. By this plan, the writer adds, the progress of electrotherapeutics is made to keep pace with the rapid strides in electrical science, and every discovery in methods of generation and transformation of electric energy finds therapeutic application, when this is possible.

An Interesting Long-Distance Power-Transmission Plant is in course of construction at Fresno, California, which is unique in more than one particular. The head of water to be used is 1,410ft., and the distance of transmission about 35 miles. The natural conditions surrounding the installation are extraordinary in themselves. The water for supplying the power is taken from the North Fork of the San Joaquin river. The stream of the North Fork runs for several miles down a rocky canyon, forming rapids and cataracts as it runs between the steep mountains. At the head of the rapids a canal will take the water out upon the summit of a high ridge, which it will follow for six miles to a point nearly 1,500ft. above the San Joaquin river. Here a reservoir has been constructed with an average depth of 10ft. It covers about

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eight acres, and can be made both larger and deeper should the demand for power require an extension. Into this reservoir the water brought along the ridge by the canal will be stored, but it will be used solely as an emergency reserve. It is calculated that it will hold enough water to drive the machinery for several days, so that should a break occur between the reservoir and the source of supply the electrical work could continue until the repair was effected. A pipe line runs directly from the canal, a distance of about 4,000ft., to the power-house, and the head of water obtained will not be less than 1,410ft. The pressure at the bottom will be 600lb. to the square inch. The lower end of the pipe line is of welded steel pipe, $\frac{3}{4}$in. in thickness, having special steel flanges and special packing at the joints. The lowest amount of water power available is at least 7,000 h.p. at the head above mentioned. All possible accidents are provided against. Should a break occur near the lower end of the pipe, the rush of water would form a vacuum near the upper portion of the pipe and it might collapse under atmospheric pressure. An air-valve will be placed near the top to provide against this contingency. The pipes will be made in sections of 20ft. each. At the upper end the metal will be $\frac{1}{4}$in. thick and the pipe 24in. in diameter. It will be fastened to the granite mountain sides by steel cables. The power station will be located at the bottom of the mountain and will contain three Pelton waterwheels, 58in. in diameter, driven by a single nozzle. The generating plant will consist of three 340-kilowatt General Electric three-phase machines. From the point in the North Fork of the San Joaquin river, where the water is taken to the power-house at the foot of the mountain, is a distance of about seven miles. From the power-house to Fresno, where the electricity will be utilised, is about 31$\frac{1}{2}$ miles in a direct line or 35 miles over the electric wires. The line will consist of two circuits of bare copper wire, consisting of six wires strung on poles 40ft. high. The current will be delivered to the lines at a voltage of 11,000. From the power-house the line will rise to the level of the San Joaquin, cross it and pass through a portion of the Auberry valley, then rising over the Red Mountain, passing about a mile west of Clovis, will continue direct to Fresno. The first five miles will be over moderately level country, the other 30 through an open and practically level country, under ideal conditions for transmission. It is estimated that the power which will be delivered in Fresno at present from the three-phase generators will not be less than 900 h.p. At the Fresno end the line will be brought into a sub-station and the current will be transformed down. From the sub-station power will be delivered to all the mills in the town, the waterworks, machine shops, planing-mills, laundries, printing-presses, elevators, packing-houses, etc. It will also be used to drive the street railway system of the city, which will require about 300 h.p. In the sub-station two arc dynamos, each of 60 lamps capacity, will be driven by an induction motor, the motor being mounted on the same bedplate as, and being directly connected to, the dynamo. Current will be supplied for 4,400 incandescent lamps.

New Standards of Length at Mason College.—There has recently been laid down in the yard between the Science and Medical Schools of Mason College, Birmingham, a series of exact standards of length, the longest being 100ft. The series of lengths marked is—

4in.	$6\frac{2}{10}$ft.	10ft.	33ft.	50ft.	66ft.	100ft.
100mm.	2m.	3m.	10m.	—	20m.	—

There are thus seven lengths marked in English units and five in French units. They are defined by fine lines scribed upon the polished horizontal surfaces of hard gunmetal plates. These are leaded into recesses cut in the upper surfaces of large blocks of the Welsh sandstone grit called "Minerva." The plates were first carefully bedded in these recesses, and then, after the lead was poured and cold, it was hammered up hard with hammer and punch. The stones are 10in. by 10in. at their upper surfaces, their bases, about 14in. square, being from 16in. to 20in. deep. They are a remnant of a quantity of stone employed round the doorway of the bottom entrance to the council house, nearest the Town Hall, and had been kept seasoning in Messrs. Barnsley and Sons' storeyard for 15 years before being used. These blocks are bedded upon Portland cement concrete 9in. deep, and the concrete is built up to the surface monolithically round each stone a thickness of 10in. to 12in. The foundation of this yard is itself a concrete almost as hard and solid as are the newly-set monolithic masses, which are each about 2ft. 6in. to 3ft. square by 2ft. 3in. deep. This part of the work was done by Messrs. Barnsley and Sons, and the gunmetal plates were supplied by Messrs. Hunt and Mitton. For the protection of the plates, each is covered by a stout brass plate easily removed by merely loosening one screw, and each stone block is covered by a large wooden block to prevent barrows and carts being taken over it. The lengths were transferred from a 100ft. steel tape. The marks on these steel tapes are coarse, but each mark has its two edges fairly sharply defined, and the measurement was in each case taken from the centre between these two edges. The tape was sent to Kew Observatory to have its errors at the places to be used tested. These errors were then measured at recorded temperatures, and under a constant pull of 3lb. applied to the tape. The tape was then stretched across the college yard with precisely the same pull kept constant throughout the whole work of marking off. The work of marking off was done by Mr. William Mavitta, of 88, Aston-street, Birmingham, and Prof. Smith left entirely in his hands the determination of the method to be followed. Mr. Mavitta has done this work free of charge, out of love of his special work, and for the benefit of the college and the town. A fine steel wire was stretched across the series of blocks, and from this the scribed cross-lines were squared off. The actual marking off was done by help of a micrometer screw instrument specially designed and made by Mr. Mavitta for this occasion, it being graduated to 1-1000th of an inch. For each mark the error as found at Kew, due correction being made for change of temperature, was measured off by help of this instrument from the exactly-measured centre of the line on the steel tape. The instrument then immediately made the mark upon the gunmetal plate. The temperature through this marking was higher than that at which the tape had been tested at Kew. Mr. Mavitta was assisted by Mr. H. M. Waynforth in the calculation of the temperature corrections. Prof. Smith feels confident that no error of so much as one-hundredth of an inch occurs in any of the scribed lines. Unfortunately, the yard is not a dead level, so that the 100ft. block stands 11$\frac{1}{2}$in. higher than the others. Up to 66ft., however, the line is practically level. The cost of this work has been considerable, and has been defrayed partly by the college and partly by subscriptions from Messrs. Matthew and Son, Lea and Thornberry, Heuman, Rabone, J. Cossins, R. Godfrey, the Architectural Association, and Prof. Smith. The college council has given authority to allow engineers, surveyors, architects, and instrument-makers to test their chains and other instruments on these standards free of charge during the present year, and until other regulations may become necessary. They are, it is stated, the only accurate standards of long length existing in the Midlands.

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PHASING TRANSFORMERS.*

BY CHARLES S. BRADLEY.

The polyphase motor is so good as to need but very little, if any, improvement, but this is so familiar to the institute that I need not go into details. I think the time is not far distant when we shall be able to fill out with the alternating currents any engineering problem that may be required of us. We will be able to take old plants and modify them to do any work which may be necessary. One of the important links to round out the art seems to be the phasing transformer, so that we can take a single-phase alternating current and convert it into polyphase of any desired number.

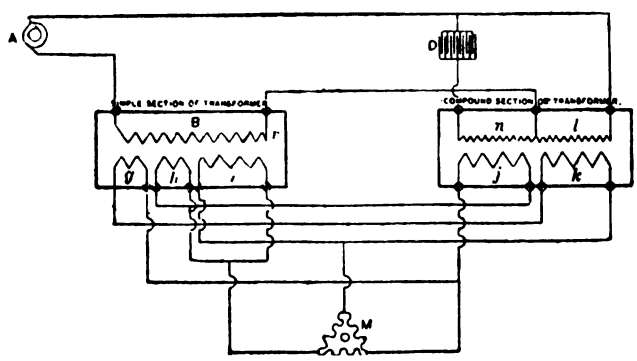

FIG. 1.

I have chosen for my work the conversion of single phase to three phase, because the three-phase motors which we have been able to construct give us very much less trouble than the two-phase. In a series of experiments, I have found that the two-phase motor would run at a number of speeds, especially when supplied with current from a phasing transformer. I suppose the trouble arose from harmonics, but of this I am not certain. The triphase motor never has given us any of this trouble. These experiments, however, were carried out before the transformers had been refined; and, now that we are getting more perfect results, I think it is very probable that we could return to the two-phase motor and get much better results than when first tried. The following is a description of an arrangement of condensers and cores to produce polyphase and single-phase alternating currents. Many different arrangements of condensers and inductances have been tried, and all have failed to keep their phases at a working relation, except the one I am about to describe.

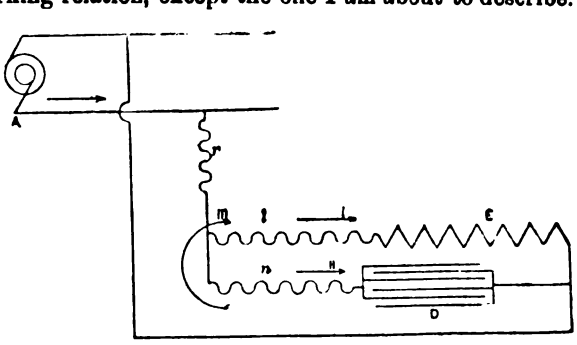

FIG. 2.

A diagram of the phasing transformer and connections with the generator and motor will be found in Fig. 1, A being the generator, B the simple section of the transformer, D the condenser, and M the motor; r, primary of the simple section of the transformer; n and l, primary of the compound section; g, h, and i, secondaries of the simple section of the transformer; and j and k, secondaries of the compound section. The primary of the simple section of the transformer is in series with the compound section and condenser. By the proper adjustment of capacity and inductance, the magnetic flux in the core of the compound section is approximately 90deg. in phase behind the simple section; then, in order to get three phases from the two, I resort to resultants in the secondaries: g and k constitute one phase, h and j a second, and i the third. The essence of this invention rests in the arrangement of the compound section of the transformer and condenser. In order to explain the theory involved in this, refer to Fig. 2, in which A is the generator, E the inductance, D a condenser or capacity, l and n represent the leads to the inductance, E, and to the capacity, D. If the generator is generating an E.M.F. in the direction of the arrow, Fig. 2, a current will flow through the lead l and the inductance, E, as represented by the arrow I., and through n into D, in the direction of the arrow II., as indicated by the curves in Fig. 3—that is, during the rise of the E.M.F. through the machine from the point o to the top of the wave at p, the current will flow in parallel into or through the inductance, E, and the capacity, D

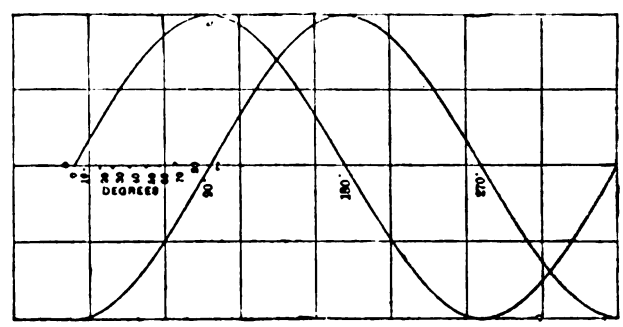

FIG. 3.

(Fig. 2). As soon as the wave of the E.M.F. commences to decline from the point p the condenser will begin to discharge, and the current flowing from it will be in the direction of the arrow III. (Fig. 2). Also, at the same time, the inductance will discharge its energy by a current in the direction of arrow III., so that the current represented by arrow III. will cross the zero line at point t (Fig. 3) or is delayed by a time equal to 90deg. Thus, we see that the current represented by arrow III. will be lagging in its time period considerably behind that in the lead r, represented by curve op. Now, if we wind the lead l and the lead n upon an iron core, as shown in Fig. 4, in opposite directions and of the same number of turns, and have the inductance, E, bear a proper relation to the capacity, D, so that the currents represented by arrow I. and arrow II. shall be equal, no magnetic flux will be produced in the core during the rise of the potential of the machine from o to p on the curve, but during the fall of the E.M.F. of the machine, and during the discharge of the inductance and condenser which is represented by arrow III. (Fig. 2),

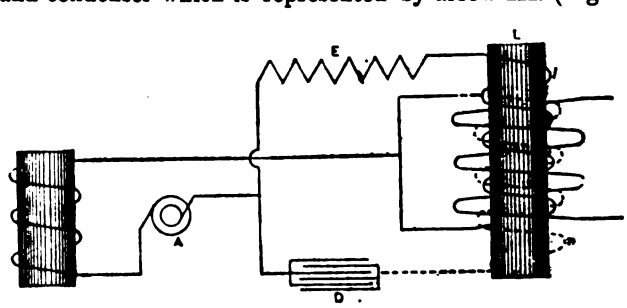

FIG. 4.

the currents flowing through n and l will be in series and flowing in the same direction; consequently, the magnetic flux will be approximately 90deg. later than it would be if charged directly from the machine. I have represented in Fig. 2 a section of lead by r, and it will now be clearly seen that the current in the lead r will have a phase difference from the combined or resultant phases in the leads l and n. Furthermore, a current in the lead r will be in lead of the E.M.F. of the machine, because the inductance and the condenser, previously described, cut off the flow of the current before the machine has reached the zero point, and when the lead r is placed upon an iron core, as shown in Fig. 4, it has a tendency to lag, which counterbalances the lead, and leaves the main line current somewhere near in phase with the E.M.F. of the generator.

* Abstract of paper read before the American Institute of Electrical Engineers, September 25, 1895.

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Refer, now, to Fig. 4, where the leads *l* and *n* are wound in opposite directions, and completely interlaced upon the iron core, L, the generator, inductance, and capacity being indicated by the same symbols as in previous figures. The lead *r* is here wound upon the second iron core, which constitutes the primary of the simple section of the transformer, as shown at B (Fig. 1). In reducing to practice and applying the transformer to an induction motor, we find that the inductance, E, can be dispensed with, as the apparent inductance produced by the motor furnishes all the lag necessary; and it will be noted that in Fig. 1 the extra inductance which we used in our first experiments is left out of the combination. The lead from the simple section of the transformer, it will be noted, goes to the

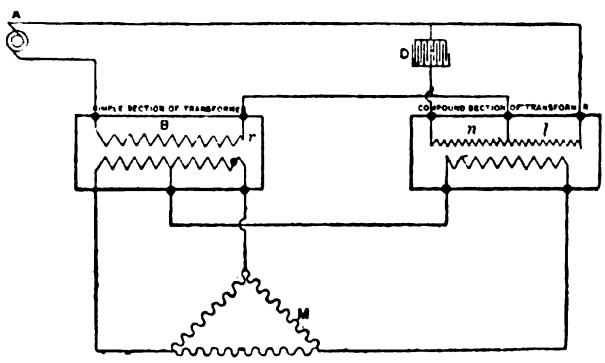
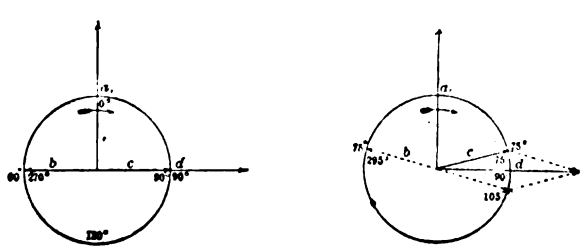


FIG. 5.

centre of the compound section. This diagram does not represent the true condition of the compound section, for the windings, *n* and *l*, are together, or, as before mentioned, interlaced upon the core. The magnetic flux in the two sections of the transformer are approximately 90deg. apart. The secondaries are therefore wound each partially upon the two cores, so that the three resultant phases may be produced from two, this being in accordance with Mr. Fred. S. Hunting's invention for changing two phases to three.

Mr. Scott's invention for changing two phases to three may also be used, and is shown in Fig. 5. Making the resultants in this manner by means of the secondary windings contributes also to steadiness of phasing. If desired, two secondaries having a proper two-phase relation may be used on the motor.

The experimental work, in which I have been greatly assisted by Messrs. Hulse and Chapman, has occupied a long time, and has passed through a great many stages. The ½-h.p. motor gives powerful starting torque. (The motor was shown in operation.)



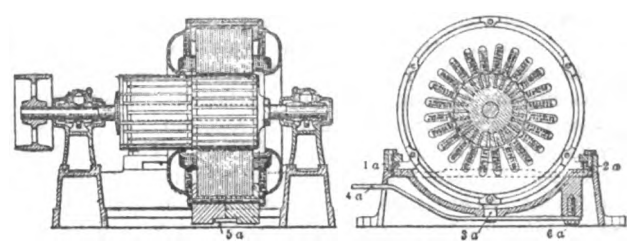
FIGS. 6 AND 7.

I want to bring to your attention one feature of the compound coil used in combination with the condenser, which will be found in Figs. 6 and 7. If we suppose a direction of motion as shown by the arrow and the current in the condenser branch leads by 90deg., which is represented at *b*, and the current in the inductance branch lags by 90deg., as indicated at *c*, and the wires carrying these currents are wound in opposite directions upon the core, we will have a resultant current, which is represented by extension *d*. Increase of load changes the phase relation of the individual branches, but not the resultant secondary, and this is explained by reference to Fig. 7, where a 75deg. lead and a 75deg. lag are represented by the respective branches, and, as the branches are wound in opposite directions, we find that when *b* is turned over it becomes a lag of 105deg., and the resultant of 75deg. and 105deg. again produce 90deg. lag, and the value again represented by the extension *d*, the value of the current is slightly less, but its resultant phase is the same as is represented in Fig. 6. This explains the steadiness of phasing which we are able to obtain.

The power factor is found to be very good. The current in the main line feeding the transformer varies from 10deg. lead at full load to 35deg. lag at no load, and the motor at starting produces the same effect as when working at full load, so that we have very good phasing for starting and full load, as well as a good power factor, it being 82 per cent. even at light loads, and the probability is that we will have very much better results upon larger-sized transformers.

The condenser in this combination fills two very important functions: first, assists in the phasing; and, second, prevents the lag upon the line. This arrangement does not prevent the idle currents flowing in the motor circuits, and the secondaries of the phasing transformer, and we find in small motors with the high period of 140 cycles that the apparent energy in the motor circuits is sometimes 2½ times the apparent energy in the main line. The capacity of condenser for a ½-h.p. motor when 1,000 volts are supplied to the transformer is about 2·4 microfarads. Our condenser for this size, without connections, occupies a space of a cube 4in. on each side and capable of enduring 3,000 volts, or a factor of safety of 4, as the voltage of the condenser is about 700. Of course, it will be understood by those familiar with the designs of induction motors that it is impossible to design a small motor with small power factor, as the air-gap necessary for mechanical construction has to be so large in proportion to the size of the motor.

Many attempts have been made by placing the condenser in direct connection with motors to produce rotary fields, but have so far been attended with little success; as the



FIGS. 8 AND 9.

trade requires the motor to be of comparatively low voltage, which calls for a large capacity in the condenser, and as the output of the condenser of a given capacity is proportional to the square of the voltage, it will be seen how advantageous it is to place the condenser in combination with the primary of the step-down transformer.

It may seem trite to call your attention to the fact that the transformer reduces the voltage at the same time it does the phasing, but I think it is so important that I wish particularly to emphasise the fact. It is also of great importance that the device has no moving parts.

While the principal use for this device at present seems to be the application of polyphase motors to single-phase lighting systems, many new ones, undoubtedly, will be found. It may seem bold to think of applying this to long-distance trolley railroads, but I am hoping to have it done. It is much more simple to have one trolley wire with track return, than to have two trolley wires which would be required by the direct application of polyphase systems. A large amount of power requires either a large current or high voltage, in order that the resistance of contact of whatever device is used to make connection to line need not be too great. As viewed at present, it seems as if the alternating current must be used for this work. If so, and unless the traffic is extremely frequent, it will take many more transformers, if they be placed along the line, than if the transformation is made upon the car or locomotive, because the transformers along the line, having no trains or cars near them, would be idle. If the voltage is stepped down on the car or locomotive, it is just as economical to do it by the phasing transformer, with the exception of the added weight of condensers, which for a 1,200-h.p locomotive will be about two tons, and this is not of consequence on so large a power.

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Cuts of the motor are shown in Figs. 8 and 9, the rotary field being the exterior or stationary part, and the secondary or induced constituting the armature. The armature is composed of two sections, or practically two armatures end to end upon the same shaft, one of the armatures having a low-resistance winding, and the other a comparatively high resistance. The field is placed over a high resistance for starting, and shifted by means of a lever over the low resistance, when it has nearly attained speed. Of course, this arrangement is for securing the starting up of the motor, and has nothing to do with the phasing transformer, and the motor might have rings for connecting the starting resistance to the armature and operate quite as well. The sliding of the field gave trouble, as the air-gap has to be small, and the play at the sides noted 1*a* and 2*a*) allowed the armature to strike against the field, and when a tight fit was made, which would work easily when cold, it would stick fast when the motor rose in temperature; the writer therefore decided to give it quite a clearance at these points, and give it a guide at the bottom of the field (shown at 3*a*). This being central and comparatively thin, the expansion is not sufficient to cause sticking, also the guides at 1*a* and 2*a*, being thin vertically, they may fit close and still slide easily. The lever for moving crown back and forth is shown at 4*a*, Fig. 9, and 5*a*, Fig. 8. It fits loosely, having a fulcrum at 6*a*.

REGULATION OF ALTERNATING DYNAMOS.

BY W. L. R. EMMET.

The maintenance of a constant pressure at lamps is a problem of much greater intricacy on alternating than on direct current circuits, since there are more conditions to be considered. Good results may, however, be obtained with as much accuracy in one case as in the other if proper methods are used. The causes of error in a direct-current circuit are: (1) variations of pressure at dynamo terminals due to armature reaction and resistance; (2) variations due to resistances of lines. The variation in both cases depends solely upon the amount of current in the circuit. In an alternating circuit the same causes of error exist, and in addition we have variations of another class which are due to periodic E.M.F.'s of self-induction, introduced into the circuit through the dynamos, lines, or load. These E.M.F.'s are in quadrature with the current, and their effect upon regulation depends largely upon the ratio existing between their total amount and the amount of generated E.M.F. in phase with the current. Where the amount of E.M.F. of self induction is small compared to the E.M.F. in phase with the current, the effect of a given amount is less than it would be if the whole were larger in proportion to the E.M.F. in phase with the current. Thus, in order that E.M.F. of self-induction may influence a circuit seriously, it must exist in sufficient quantity to give character to the circuit. The effects of self-induction on a circuit may be illustrated by lines and angles.

In the two diagrams, Fig. 1, the length of lines, A B, represent E.M.F.'s in circuit which are in phase with the current. The lengths of lines, C B, represent E.M.F.'s of self-induction which are in quadrature with the current. The lines, A C, represent the generated E.M.F. necessary to produce the current flow. The E.M.F. in phase with the current represented by A B is alone effective in doing work. The lines, B D, being the difference between A C and A B, represents the increase of generated E.M.F. made necessary by the self-induction in the circuit, or the effect of the self-induction upon the regulation. No matter in what part of the circuit the self-induction exists, its effect on the generated E.M.F. is the same. Thus, in an alternator, the E.M.F. at the terminals is not the generated E.M.F., but is the resultant of the generated E.M.F., and the E.M.F. of self-induction in the armature. Thus, the E.M.F. which is shown by a voltmeter at the terminals of an alternator is not the true E.M.F. which is effective in the circuit, and may depart from it more or less according to the condition of inductance of the machine and of its load.

There is a wide difference in the degrees of self-induction of different alternators, but none is entirely without self-induction; thus, every alternator requires somewhat different regulation for inductive than for non-inductive load, the current never being in exact proportion to the losses to be compensated for.

The only practical method of adjusting the generated E.M.F. of an alternator is through variations of its field strength, which may be accomplished either by hand, through adjustments of the exciting potential, or automatically, either by rectifying a portion of its current on a commutator and using it in a series winding, or by using some other device by which the excitation is increased as the load on the machine rises. Since, as we have shown, the required generator E.M.F. does not depend directly on the current, these automatic means of regulation must be more or less inaccurate. They are, however, of very great value, since they confine the variations to certain narrow limits, and make less frequent the necessity of hand adjustments, and also make the effects of neglect by attendants less harmful.

Alternators may generally be divided into two classes—namely, high-inductance machines and low-inductance machines. There are machines built and advocated by prominent makers which are typical of both these classes, and there are, of course, others of all degrees of inductance between these extremes. Both these types have certain inherent merits and defects. It will be well to explain here that the degree of self-induction or inductance is not the only feature which distinguishes the two types of machines, but that it is, incidentally, more or less characteristic of them. In the machines which we classify as of high inductance a comparatively large number of turns are used on the armature to each field pole, thus making the magnetic flux for a given E.M.F. small. This

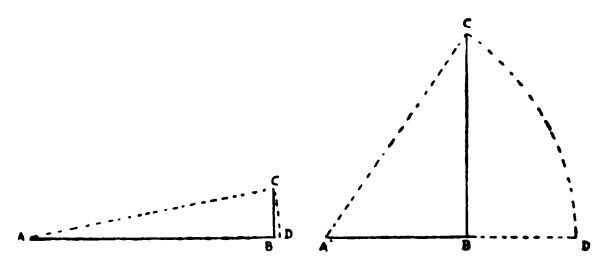

FIG. 1.

construction gives a large demagnetising effect of armature on field. The massing together of these armature-turns in large slots gives rise to more or less self-induction; this, however, is never excessive in well-designed machines. The types of machine which we have classified as of low inductance have relatively few armature-turns per poles, generally less self-induction.

Since the design of the machine has an important bearing on its regulation, we will briefly review some of the peculiarities of these classes. The typical machine of high inductance has a slotted armature with one slot per pole, the slots are large, and are filled by coils of many turns of wire. The inductance of such a machine is increased by making the slots deep and narrow, by extending the teeth over the coils so as to reduce the magnetic reluctance around the coil, and by increasing the number of ampere-turns per coil in the armature. Reduction of the air-gap may, in some machines, increase the self-induction appreciably. The advantage of machines of this class are:

1. For a given cost they may be made much more efficient than machines of low inductance. This difference in efficiencies is particularly marked at light load, since the principal saving in the high-inductance machine is through core loss and exciting current, which losses go on at all loads.

2. The machines are adapted to safe operation in parallel, since the current cannot rise to a dangerous degree if the machines are thrown out of step.

3. For the same reason the machine cannot be injured mechanically or otherwise by short-circuits.

4. The structure is simple, the space occupied by insulation being small, and the coils few in number. The principal disadvantage of machines of this type is that their inherent regulation is not good—that is, a wide variation of field strength is necessary for different loads. This variation is

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usually provided by compounding the field with rectified current from the armature circuit. This commutation, which in some machines is a matter of serious practical difficulty, is somewhat facilitated in machines of this class by the fact that the total power required in the field is small.

Many different types of low-inductance machines have been used to a considerable extent; they are, however, much less used now than formerly. Among them may be mentioned the flat-coiled, smooth-body machines once in general use, also the various machines built without iron in the armature, like the Faranti, Mordey, and Brush types. A more modern form of low-inductance machine is built with an armature having many small slots with distributed windings. In such machine the self-inductance may be made low at low current ratings, and if the ampere-turns per pole are kept low, the inherent regulation may be made close. Such results can, however, be obtained only at the expense of material and of efficiency. The expense of such machines is greatly increased when they are built for low frequencies. The main advantage that can be claimed for any of the machines of this class is that they may be made to regulate within comparatively narrow limits without compounding, or that they require, if compounded, a relatively small amount of series field. It will usually be found, however, that to get this regulation without undue expense, the iron is run near saturation, and that proper compounding is impossible. One of the greatest disadvantages of such machines is that they are unsafe in case of short-circuits, or when used in parallel.

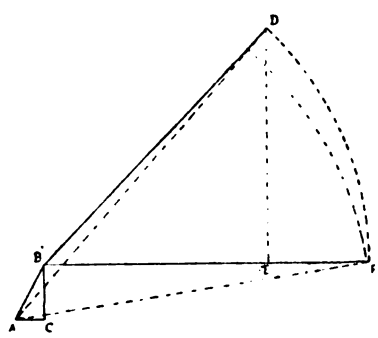

FIG. 2.

The field being intense, and usually partially saturated, and the armature-turns being few in number and of low self-induction, the demagnetising effect of the armature is small, and there is nothing to check the flow of current. The result is that when short-circuits occur, armatures are stripped, shafts are twisted, and belts, or flywheels, or engines are broken.

The ideal alternator is one having a moderately high armature reaction with its iron worked well below saturation, and with its field compounded to suit the conditions of its operation if automatic regulation is desired. A moderate amount of self-induction cannot be avoided in such machines, and is not objectionable. By a suitable proportioning of the slots the self-induction is kept within the proper limits. Such a machine is safe and stable under all conditions; it has a straight compounding curve, a high efficiency, and a small exciting current.

No matter what the design of a machine may be, it must always require a considerable field variation for different loads; the amount of this variation is widely different in different machines. Machines of high armature reaction and self-induction may require twice or three times the field excitation at full load that is needed at no load for a given E.M.F. In some machines of extreme design there may be as little as 5 per cent. difference between the full load and no load excitation if the load be non-inductive. The best modern alternators require from 30 to 60 per cent. increase in field excitation between no load and full non-inductive load.

It has been partly explained in the beginning of this article that the character of the load has an important bearing on the regulation of a dynamo. If the load on the dynamo be non-inductive, the effect of the armature self-induction upon regulation is slight; if the load be inductive, the effect of armature self-induction is greater, it being necessary to generate a greater E.M.F. in order to get a given E.M.F. at the dynamo terminals. This may be illustrated by a figure.

Let the length of the line A C represent in any desired unit the volts lost in the armature due to consumption of energy in heating the wire, core, etc.; let B C represent the volts lost in armature in overcoming the counter E.M.F. of self-induction; let B F represent the volts required at the terminals of a load having no self-induction, and let B D, drawn equal in length to B F, represent the same number of volts required at the terminals of an inductive load. B E is the energy component, B D, and represents the volts in phase with the currents which are effective to do work. D E is the induction component of B D. The line A D represents in the units chosen the E.M.F. which must be generated in the case where the load is inductive, and the line A F, which is less than A D, represents the volts which must be generated in the case where the load is non-inductive. Thus, although the volts at the terminals of the machine are the same in both cases, the field for a given speed must be stronger in the case where the load is inductive.

The variation just described is prominent among the many causes of error which effect the regulation of alternating circuits. Its importance in recent times is continually increasing since we are beginning to have motors and arc lamps on our circuits which tend to give an inductive character to the load. It is not necessary, however, to have motors and arc lamps to get a considerable degree of inductance in alternating circuits during times when the load is light and transformers are being worked far below their ratio capacity.—*Electric Power.*

NEWPORT (MON.) ELECTRICITY WORKS.

The Newport central station was opened last Monday. We abstract the following from a printed description of the station kindly forwarded to us by the consulting engineer, Mr. R. Hammond, M.I.M.E. The Newport provisional order was obtained in 1891. Mr. Hammond was selected as consulting engineer and reported towards the end of 1893. His recommendations were adopted and specifications issued, upon which the following contracts were made:

Buildings—Including foundations for engines, boilers, alternators, etc., Messrs. William Gradwell and Co., Barrow-in-Furness.
Generating Plant—Boilers, mechanical stokers, pumps and heaters, steam and exhaust pipes, alternator and exciters, switchboard and instruments, day-load plant, Messrs. John Fowler and Co., Limited. Leeds.
Engines—The Uskside Engineering Company, Newport.
Distribution—Converters, culverts, arc lamps and posts, meters, Messrs. John Fowler and Co., Limited, Leeds.
Cables—Messrs. Siemens Bros. and Co., Limited, London.

The site was selected for convenience of water and coal supply. Current is supplied from the alternators at 2,000 volts, and transformed down to 100 volts. In the boiler-house is a battery of four Lancashire boilers. Each boiler is 28ft. long and 7ft. 6in. in diameter, with a grate surface of 36 square feet, and the flues 3ft. in diameter. The shell is of mild steel $\frac{2}{3}\frac{3}{2}$in. thick. Each ring of the shell is made in a whole plate with longitudinal seams, butt-jointed, and connected by double-covered straps. Hopkinson's fittings only are used. The working pressure is 125lb., but the boilers are capable of working up to 150lb. per square inch, and each boiler is capable of evaporating 4,500lb. of water per hour with the feed supply at a temperature of 60deg. F. The boilers are fitted with Proctor's mechanical stokers. Meldrum's system of forced draught is also fitted to the boilers. There are three duplex feed pumps, each capable of delivering 1,500 gallons of water per hour at a piston speed of 50ft. per minute. Three Berryman feed-water heaters are erected. The boiler-house plant includes one of Worthington's self-acting jet condensers, which when the engines are working condensing maintains a constant vacuum of 27in., and is capable of condensing the exhaust steam of 750 i.h.p. of engines working at their full capacity. The condenser has two high-pressure cylinders and two double-acting injection water plungers.

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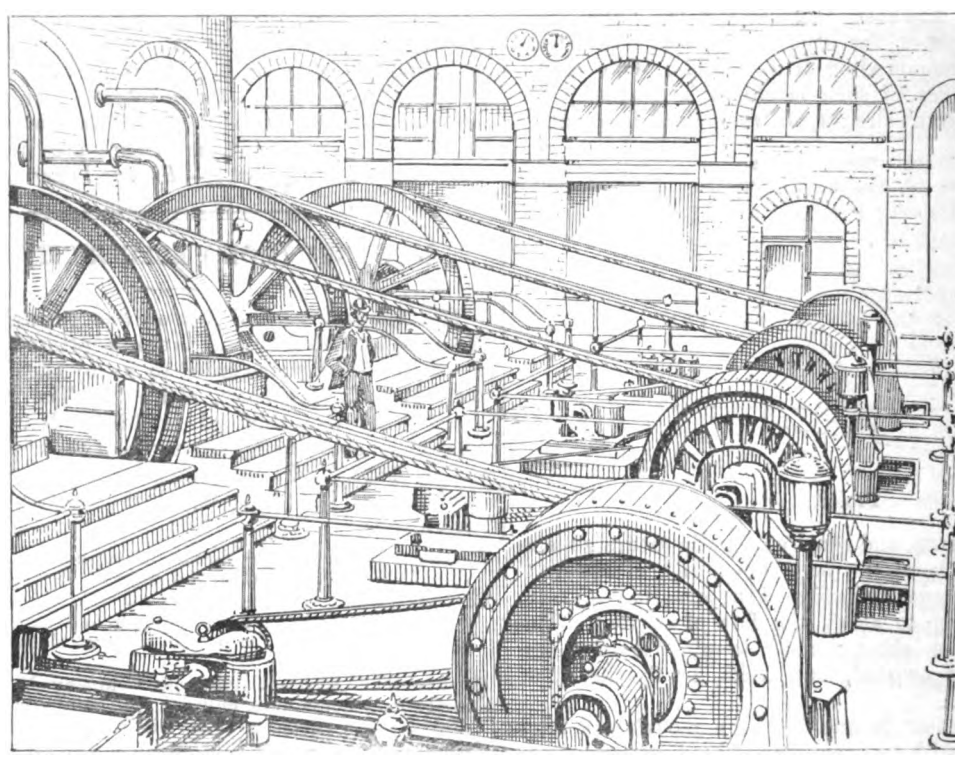
The engine-house is 93ft. long by 50ft. wide, and contains four 150-i.h.p. engines, four 75-kilowatt alternators, switchboard, temporary plant—viz., 100-i.h.p. engine and 75-kilowatt alternator, and an overhead travelling crane capable of lifting up 10 tons.

The engines are of the horizontal, compound, coupled, condensing type, and were manufactured by the Uskside Engineering and Rivet Company at their Newport works. They are arranged for working in conjunction with the separate condenser, and are each capable of giving off a continuous load of 150 i.h.p. The ordinary working steam pressure is 125lb., and the speed 110 revolutions per minute. In cases of emergency the engines are capable of working up to 180 i.h.p. by a slight increase in the steam pressure. The dimensions of the engines are as follow: high-pressure cylinder, 13in. diameter; low-pressure cylinder, 24in. diameter; length of stroke, 24in.; piston-rods, 2¾in. diameter; crankshaft, 7½in. diameter, increased to 9½in. at the flywheel; bearings, 7½in. diameter, 15in. long; crank-pins, 5½in. diameter, 6in. long.

The flywheels are 12ft. in diameter, and weigh over eight tons each. They are grooved for eight ropes of 1¼in. diameter. The expansion valves of both cylinders are controlled by Hartnell's vertical high-speed governors. The variation of speed when the load is suddenly switched on or off does not exceed 5 per cent. from friction load to full load. The following are the results of the official test of one of the engines carried out by the consulting engineer:

Total coal consumption	3,840lb.
Total water consumption	30,736lb.
Mean indicated horse-power	139
Consumption of water per indicated horse-power per hour	18·4
Consumption of water per kilowatt-hour	34·15
Consumption of coal per indicated horse-power per hour	2·3
Water evaporated per pound of coal from and at 212deg.F.	9·52

The alternators (Hall's patent) are driven by eight cotton ropes of 1¼in. diameter, each giving an output of 75 kilowatts, and capable of supplying current to 2,500 lamps of 8 c.p. A good margin for overloading is arranged for, each machine being capable of working for one hour up to 90 kilowatts. The speed is 525 revolutions per minute, and the mean speed at which the armature conductor is passed by the field magnets is about 7,000ft. per minute. The periodicity is 87 complete periods per second, and the E.M.F. 2,000 volts. The armature is stationary, with iron core of large section composed of charcoal iron sheets arranged longitudinally and in the same plane with the magnetic fields, clamped to the frame of the machine and thoroughly insulated. The armature conductor coils are formed of narrow copper tape, each wound upon a piece of insulating material of the same width as the tape, and rounded at the ends. The coils are thus of a flat link shape, the edges of the tape windings being exposed upon the flat surfaces of the coils, and therefore well able to resist deflection. These coils are placed close together upon the cylindrical inner surface of the armature ring, so that the axis of each coil is radial to the ring, and are secured to the same by strips of wood screwed to the cheeks, and extended over the ends of coil, outside the line of travel of the magnets. By this mode of construction the whole of the conductor (except a small portion at the ends of the coils outside the line of the field, and therefore useless for inductive purposes) is placed in a strong and uniform field of force. The armature is built in sections, and so arranged that each coil and its section of laminated iron core can be withdrawn from the machine without touching the bearings or the field magnets. The moving parts of the machine are the field magnets, which are wound on laminated iron cores. The grooved pulleys are supported by outside bearings. The bearings are all long, and have large surfaces, and are, moreover, provided with water jackets and water fittings.



View of Engine-house, Monmouth Electricity Works.

The exciters are continuous-current shunt-wound machines with Gramme armature, and are driven by ropes from the alternator shaft. The exciting current of the alternators at full load is about 18 amperes at a pressure of 100 volts.

The switchboard, upon which all the electrical connections converge, is fixed at the end of the engine-house. It is fitted with a very complete set of instruments for controlling the current and regulating its distribution between the several circuits, and is well adapted for easy extension of the generating plant. It is designed to maintain high insulation. A special feature of the arrangement is found in the main switches. These are made in the shape of four metal plugs attached to a massive block of insulating material having a handle at the back. The plugs fit into porcelain sockets containing brass tubes, which are connected to the mains. A long break is made on both poles of the circuit by drawing out the plug, and forms a very efficient double-pole switch. The switchboard is arranged so that the whole of the alternators can be run in parallel or divided into two sections, the division being effected by means of a coupling switch. A hospital shunt is also fitted so that in case of emergency any circuit can be run from any dynamo quite separate from the omnibus bars.

A separate building is reserved for the day-load plant, supplied by Messrs. John Fowler and Co., and consists of

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a semi-portable under-type engine and boiler combined. The speed of the engine is 135 revolutions per minute, with the boiler working at a pressure of 140lb. per square inch. The room also contains a small feed-water heater and a donkey pump, with the necessary steam and exhaust piping. The engine drives a Hall's combined alternator and exciter, fixed on one bed-plate. A separate switch-board, complete with the necessary instruments, is provided. This is connected to the main switchboard, and is arranged so that the dynamo can be controlled at either board.

The distribution of the electricity is effected by a network of low-tension armoured cables laid direct into the ground, this network being fed by the high-tension mains at transformer-boxes constructed underground at distances of about 200 yards apart. The high-tension cables are of the vulcanised indiarubber class, and are drawn into cast-iron culverts and boxes laid chiefly under the pavements. The surface boxes are in all cases placed at the corners of the roads, and in long, straight runs they are stationed at intervals of not more than 80 to 100 yards apart. These boxes are made in two parts, the bottom part being permanent, and the upper, with the cover, being adjustable, so that its surface may be raised or lowered as the road-level may vary. The lid is filled in with wood, macadam, or pavement according to the construction of the road. The transformers are of the well-known Lowrie-Hall pattern, made by Messrs. John Fowler and Co. In the interior of each box, in addition to the transformer, are placed high and low pressure fuses, a Cardew earthing device, and high and low pressure switches. These last are double-pole and double-break, connected together by an insulated distance piece, so that both switches are turned off at the same moment, which arrangement prevents any sparking, however heavy a load may be switched off.

The rate of charge permitted by the provisional order is 8d. per unit, but the Corporation have fixed upon the following scale of charges: Up to 1,000 units per quarter, 6d. per unit; from 1,000 to 2,000 units per quarter, 5½d.; above 2,000 units per quarter, 5d. The minimum charge to any consumer is 13s. 4d. per quarter. A cash discount of 5 per cent. is allowed on accounts paid within one month. The consumer is at liberty to use his own meter, provided that it complies with the conditions laid down in the provisional order.

Mr. Hammond has been very ably seconded by Mr. R. H. Haynes, the borough engineer, and both these gentlemen have given a considerable amount of personal supervision to the progress of the work of erecting the machinery. Mr. C. D. Copland has been the resident superintendent on behalf of the consulting engineer. The architectural treatment of the buildings was entrusted to Mr. W. Conyers Kirby.

THE ROSS-HEPWORTH ARC LAMP.

This hand-feed lamp, which has been on view at the Tunbridge Wells Exhibition, is intended solely for projection purposes for lanterns, and is designed so that it can be readily attached in the place of limelight apparatus. The inventor claims that it has advantages over the automatic-feed lamps, on the score of simplicity and weight, also being less difficult to keep in order.

The lamp, as will be seen from the illustrations, consists essentially of two carbon-holders supported by guide rods, which are actuated by a pinion working between them and causing them to move in opposite directions. The pinion is connected with a tangent wheel, which engages with a worm-wheel, so that by means of a handle connected with the latter, and projecting from the back of the lamp, a slow feeding motion is imparted to both carbons at once. This feeding handle also performs another very important function in quickly bringing the carbons together in order to strike the arc; this is accomplished by merely pushing the feeding handle forward; the worm-wheel for the moment acts the part of a rack, and imparts a rapid rotary motion to the pinion, which in turn, acting upon the guide rods, brings the carbons together. A spiral spring on the feeding handle serves to instantaneously separate the carbons again, and bring them to the exact position before occupied. This quick-striking mechanism is peculiar to this lamp, and is a most important feature, as it enables the operator to set the carbons to the right distance before lighting up, and after a break in a performance it permits of immediately starting again with the carbons exactly in the same relative position as before. It also permits of the light being rapidly re-established should it from any cause become extinguished. The upper carbon-holder, which is of peculiar construction, is fitted with a milled head, by means of which

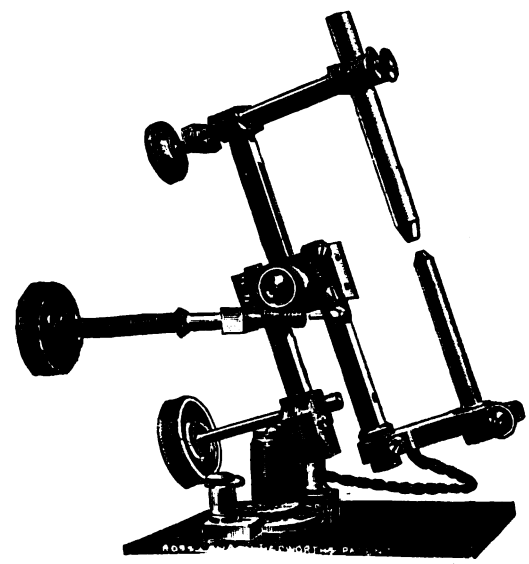

FIG. 1.

the backward displacement of the positive carbon may be adjusted with the greatest nicety, even, if necessary, while the lamp is burning. This adjustment is important, for upon its precision depends the clearness and uniformity of the disc of light upon the screen, and the ability to slightly regulate this during a performance is a valuable boon. The lamp is fitted with a vertical rack and-pinion motion for bringing the point of light into the optical centre, and for keeping it there, should any irregularity in the rate of burning of the two carbons cause a slight displacement.

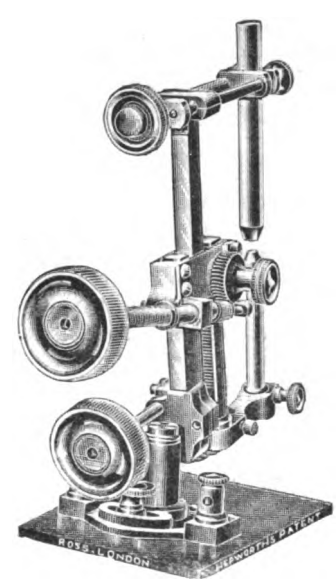

FIG. 2.

The lamp is made to take carbons of 13mm. and 10mm. diameters respectively, suitable for use with a current of from 10 to 15 amperes. When, however, it is desired to employ less current, brass adapting collars are fitted into the carbon-holders so that smaller carbons may be used.

The advantages claimed for this apparatus are an improved slow feeding movement ensuring perfect steadiness of the light; a quick arc striking movement; a fine adjustment for the backward displacement of the positive carbon; a rapid movement for separating the carbon-holders when

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retrimming, etc. The apparatus is manufactured by Messrs. Ross and Co., of New Bond-street.

THE MANUFACTURE OF THE INCANDESCENT LAMP IN ENGLAND.

It is interesting to find that the Sunbeam Lamp Company, Limited, of Gateshead, do not appear to have been in any way discouraged by the injunction brought against them some two years ago by the Edison and Swan Company; for instead of spending money in demonstrating that their lamp was not an infringement, and so disclosing their process, they spent the time profitably in laying down plant, procuring additional premises, and fitting them throughout for the special purpose of incandescent lamp manufacture. The name of the Sunbeam Lamp Company has in the past been associated with lamps of high candle-power, ranging from 150 c.p. upwards, but the plant laid down has been specially designed not only for the manufacture of the larger lamps, but for the output of the smaller lamps from 5 c.p. The manufacture of all stages is personally under the supervision of the managing director, Mr. J. W. Edmundson, who has been connected with the manufacture from its first conception, and was the first to perfect high candle-power lamps, so that no one at present engaged in the manufacture of incandescent electric lamps has had a better practical experience of actual manufacture than Mr. Edmundson, and no firm have greater facilities for perfect manufacture than the company he at present manages.

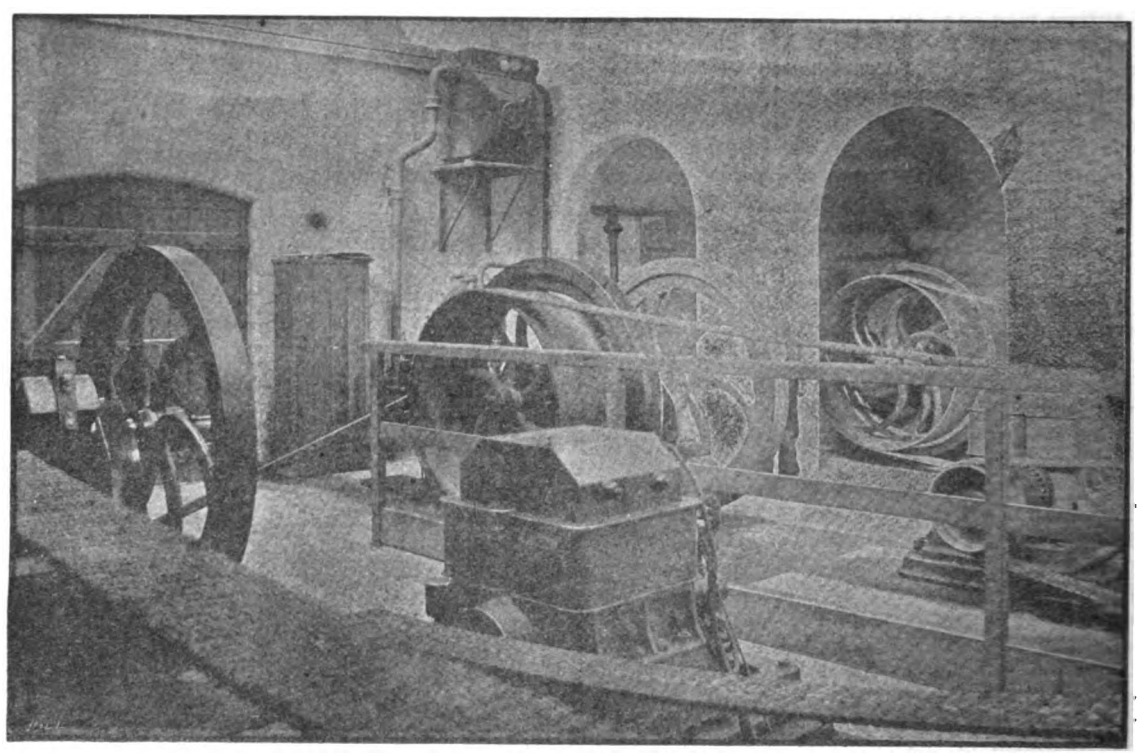

FIG. 1.

The building in which the works are situated is of both historic and romantic interest, it being made, under the name of "Gateshead Hall," the scene of the opening chapter of Charlotte Brontë's novel, "Jane Eyre." When the unfortunate fire of 1891 burnt out the interior of this building—that had stood 150 years—the company rearranged its workrooms in the most satisfactory manner. The current is supplied by four large dynamos of the Clarke-Chapman type, driven by three Otto gas-engines of 20 h.p. and 16 h.p. Fig. 1 shows the interior of the engine-room.

The main building (Fig. 2) is a three-storeyed block and has extensive cellar accommodation, which is wisely used by the company as a store-house for bulbs. The general and secretary's offices with Board-room are situated on the ground floor, where are also the packing-room, despatch office, blowroom, and exhausting department. In describing the works we shall endeavour to follow, as far as possible, the manufacture of one of these lamps. Very little information can be obtained as to the manufacture of the carbon, which the company, in their own interests, do not care to divulge. After the carbons are moulded to different sizes as may be required, they are then carefully packed in crucibles and carried to a furnace for carbonising. The filament is now taken to the depositing-room (Fig. 3), which is a branch from the main building and entirely fireproof, where it is electrically united to the platinum stems. From here we follow the filament to the treating-room, situated on the first floor, where each filament is tested separately for resistance and subjected to the process of flashing in hydro-carbon gas in order to obtain equality in the different filaments. For the next process we descend to the ground floor, where the filaments are being sealed into the glass bulbs by men and boys, no girls being employed in this operation. It is especially interesting to watch this operation with the high candle-power filaments, which can only be treated by very experienced glass-blowers, of whom this company appear to have been especially fortunate in their choice. We next are taken to the exhausting department, Fig. 4, where the lamps are sealed to a vacuum pump, and the air in the bulb extracted by means of a special system of Sprengel pumps. The experienced hand only knows when the lamp is ready for sealing off, but before doing so a very heavy current is passed through the lamps to drive out any gases that may still remain. This is a severe test, but the comparatively few lamps returned from this department speaks for itself as to the excellency of the filament. After the operation of exhausting is completed, the lamps are then handed to the testing department, where each lamp is separately tested by a Bunsen photometer. Most careful tests are made of candle-power, voltage, and efficiency, and no lamp is passed that is not equal to the standard. The lamps are thus assorted, and in order to prevent any possibility of error a few of each kind are taken and again tested on a special photometer. From here the lamps are taken to the collaring department, where they are fitted with brass caps according to requirements of various orders. From this department we are next introduced to the mounting-room, where the voltage, candle-power, and the name "Sunbeam" are marked by a special patent process on every lamp. Here also the lamps are carefully tested to ascertain that the connections are in order, and that the vacuum is perfect. The lamps are then washed and papered and sent finally to the storeroom.

The Sunbeam Lamp Company have a special brass collar,

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which is preferred by many consumers. This collar is in the form of a claw, which springs on to the top of the lamp and holds it quite firmly, and so allows a passage of air all round the lamp, keeping the latter cool, and obviating the trouble of loose collars. For those who prefer the ordinary plaster-capped lamps, the company have prepared a cement specially manufactured for the capping purpose.

In other departments the wires for supporting the carbons are being made for both large and small lamps, and similar operations as already enumerated for the small lamps are in force for the lamps of large candle-power. The company confine itself almost solely to the production of the lamps, but have patented a special holder for large incandescent lamps, and in another room these are being made of various sizes and patterns.

It is pleasing to find that the efforts of the Sunbeam Lamp Company, Limited, to manufacture a first-class English-made lamp are being rewarded. They have been compelled to increase their facilities of output, and only last month completed large extensions of plant in their endeavours to meet the ever-increasing demand for the Sunbeam lamp, which, notwithstanding the cheapness of the foreign-made article, keeps its hold on the market.

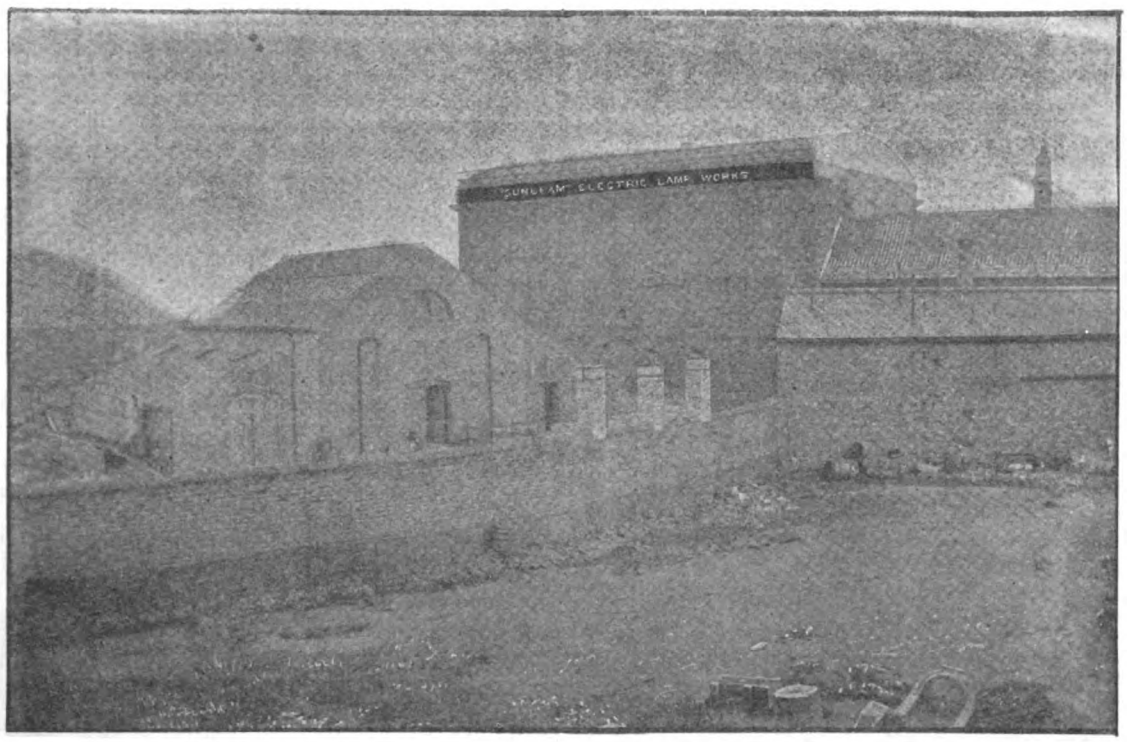

FIG. 2.

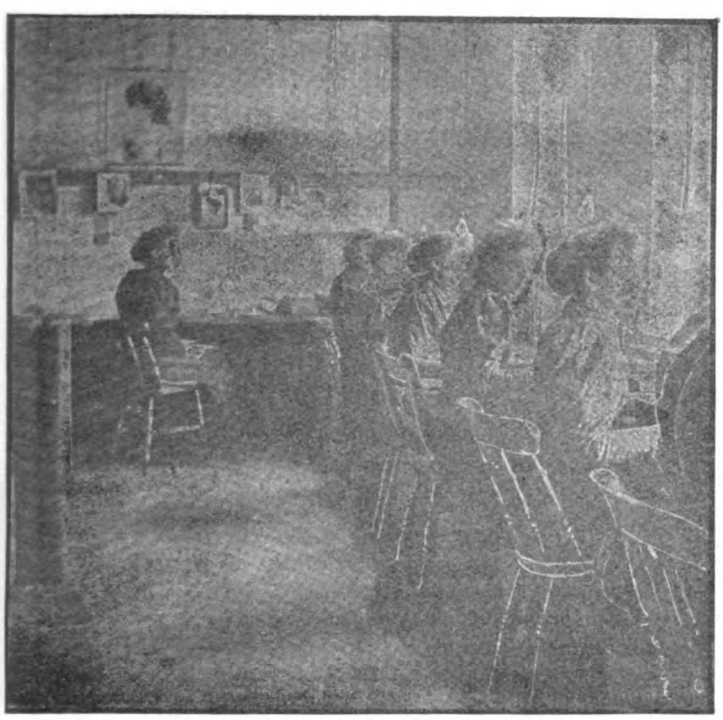

FIG. 3.

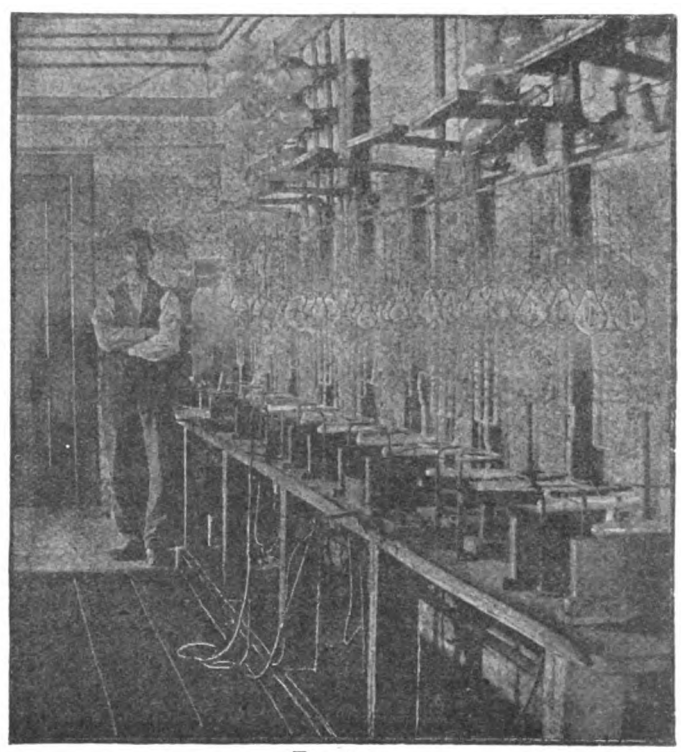

FIG. 4.

Liverpool Engineering Society.—The opening meeting of the twenty-second session of this society will be held on the evening of Wednesday, the 30th inst., at 8 o'clock, when the president-elect, Mr. Arthur J. Maginnis, M.I.N.A., will deliver his inaugural address. On February 5, 1896, Mr. W. G. P. Macmuldrow will read a paper on "Some Instruments Used for Measuring and Recording Electrical Energy"; on February 19 Mr. Alexander Ross, M.I.C.E. (past-president), will give one on "Light Railways"; and on April 1 Mr. Sherrard Cowper-Coles will discourse on "Electro-Zincing."

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. XV. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers or binding can be obtained, price 2s.

MUNICIPAL ENTERPRISE.

It is well now and again to look at the possibilities of the future as indicated by the certainties of the past. October is the month during which municipal affairs are subjected to a somewhat fierce light—for it is the month of candidates and elections. A careful examination of addresses and speeches will show that year by year there is a growing interest in electrical work. Of course, the many central stations opened and in progress show this interest; but besides these actualities, it is indeed suggestive of increasing interest to find the many references to electrical matters, for and against, to induce the electors to vote for particular candidates. At this stage of the world's history it is difficult to account for the hostility of ratepayers to the municipalities or districts embarking in electric light undertakings, except from the one view that the hostile citizens do not really understand the question. Thus it is reported that a large representative meeting of ratepayers at Wimbledon has declared against electric lighting. It is the duty of all acquainted with the subject to enlighten their fellows as far as possible, and they cannot have better opportunities than during the meetings held in support of candidates for municipal office. The great controlling influences of municipal life are two—first, that relating to the health of the community; secondly, that relating to the general comfort of the community. Under the first of these comes the question of sanitation, the supply of pure water and air; under the second, the proper maintenance of roads and streets, and the proper generation and distribution of artificial light. The commercial instinct of the nation is such that as regards water and light supply the question is often put upon the footing of pounds, shillings, and pence—that is, will it pay? In both cases the answer is and must be in the affirmative. The householders must have water and artificial light, and in these days of advanced civilisation these cannot be obtained without payment. The consideration then resolves itself into the question whether it is better for the ratepayers to co-operate and obtain what they must have in the best form at the lowest price, or take what is provided by capitalists whose object is to secure a good return for the capital advanced. There is no single instance—indeed, such an example is impossible—wherein outsiders can do better than municipalities. Of course, we assume everything in both cases is done with strict regard to integrity. As we have often pointed out before, a municipality can obtain money at a lower rate than a company, and its expenses ought never to be so heavy as those of a company. Both must keep their stations in the highest state of efficiency, but the company has besides to pay dividends, capital remaining constant, while the municipality pays off its capital, and at the end of a term of years has its property with no capital charge outstanding. It cannot for a moment be maintained that under a municipality the consumers pay more for the same supply; hence from whatever point of view the question be considered it will have to be conceded that

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the municipal control is better than that of a company. The hostility of ratepayers is unaccountable from another point of view. Under ordinary conditions—even with a comparatively small demand—the electric light station is no drag upon the rates, and, so far as we can ascertain, soon ceases to require pecuniary aid. There is one point in connection with the capital question we have never yet seen fully considered. Assume that the capital borrowed has to be paid within thirty years. At the end of that period the capital account vanishes; but it may be that the rate of paying off is too fast, and a portion of such payment has fallen upon the rates. This means that the rates have advanced a certain part of the capital, which is repaid after thirty years by the revenue then coming in aid of the rates. The above assumption is unlikely, for it seems pretty certain that every one of the central stations erected will with good management soon earn enough to keep the machinery efficient and to pay the annual return of capital, in most cases leaving something over in aid of the rates. We had intended to direct attention to various parts of Prof. Fleming's report to the Plymouth Council, but our readers will be able to see his points themselves, and we would urge those in a position to do so to take an active part in spreading abroad the true facts concerning electrical development during the forthcoming municipal elections.

OBITUARY.

THE LATE FRANKLIN L. POPE.

We regret to have to record the death of Frank Pope, who met with a fatal accident on Sunday, October 13, being killed in his own house by a shock of 3,000 volts. The late Frank Pope had endeared himself to many members of the profession on this side, and, as might be expected, to a far larger number on the other side. The time has not yet come—and will not for many years, if ever, come—when the writer can divulge a certain historic incident in which his late friend played a most prominent part. The incident carried alarm and dismay to certain patentees and financiers across the Atlantic, and rendered for ever impossible any harmonious working between these people and the writer. Frank Pope was better known, perhaps, in the telegraphic and telephonic world than in the electric light world, but his innate and versatile talent kept him fairly abreast of recent developments, and his writings show how keenly alive he was to the possibilities of electrical development. His memory will long be dear to the many with whom he lived and worked.

THE BRISTOL, ST. GEORGE, AND KINGSWOOD ELECTRIC TRAMWAYS.

This new line was opened on Monday last in the presence of a large and representative gathering of engineers. The history of the tramway company owning this line shows a steady advance, and we trust that the financial success of this new branch will be in keeping with advantages gained by the adoption of electric traction. The configuration of the roads in and round Bristol is such as to render horse traction cruelty to animals. Thus, in the line to Kingswood the maximum grade is 1 in 15, and this lasts for a distance of 220 yards, and there are several long slopes of 1 in 30, 1 in 35, etc.

The first step taken to bring about the Kingswood extension was in 1891, when a provisional order for carrying out the work was obtained; but it was not until the modified regulations recommended by the Joint Committee of both Houses of Parliament to operate electric traction were known that the Bristol directors felt justified in entering upon the project. At this stage, Mr. J. Clifton Robinson, C.E., who was the first general manager of the Bristol company, and who had subsequently acquired great experience of electric traction in America, was called in by the directors and asked to report fully on the whole subject, and particularly to formulate a scheme for an electric line to Kingswood. That gentleman's report was of such an encouraging nature that the directors accepted his recommendations, and instructed their engineer, Mr. Joseph Kincaid, M.I.C.E., to carry out the works, which he has done most successfully. The necessary powers to enable the company to proceed with their scheme of electric traction for Bristol in relation to the Kingswood Electric Tramway were obtained in 1894. The contract for the work was placed with the British Thomson-Houston Company, whose engineer, Mr. R. Blackwell, has had full charge of the equipment, Mr. Philip Dawson being his local representative.

The track to Kingswood has been entirely relaid with steel rails weighing 76lb. per yard. The copper bonds connecting adjoining rails are of the Chicago pattern, as described in our issue of September 20. This line is the first to be laid to comply with the new Board of Trade regulations concerning overhead wires and earthed returns. The requirements of these regulations were as follow: (*a*) the difference of potential between any two points on the earth return shall not exceed seven volts; (*b*) the leakage to earth from the feeders and trolley wire, etc., shall not exceed $\frac{1}{100}$ of an ampere per mile of tramway. In the most severe test to which this line has been subject the Board of Trade limits were never approached, which shows that with good attention to detail the restrictions are not prohibitive. The trolley wires are supported on standards made of steel tubes, placed mostly on the kerb of the footpath on one side of the road. A long ornamental bracket carries the insulators for the two trolley wires. In other places, where there is more width, the poles are placed in the centre of the road, and two brackets on either side are used. In Old Market-street the alternate posts are used as arc lamp-pillars. The Dickinson trolley system has been adopted, and this greatly facilitates the line construction. The power-house is equipped with two Adamson boilers, fed by Vicars stokers. The whole of the auxiliary power for driving these and the feed pumps is obtained from electric motors. Duplicate steam-pipes are used to supply three Willans engines of the H H S size, which develops some 135 i.h.p. each at a speed of 380 revolutions. These drive, by rope gearing, three Thomson-Houston four-pole dynamos, whose individual output is 200 amperes at 550 volts at a speed of 650 revolutions.

The large proportion of the work has been executed in America, and while in no way detracting from the excellence of the results, we hope that future traction work in this country will be kept more in the hands of English firms.

The opening ceremony on Monday was commenced in Old Market-street, from whence the guests were conveyed in eight cars to the Kingswood end of the line. When the guests had taken their seats, they were each presented with a beautifully illustrated description of the tramway. For more than an hour before twelve o'clock, the hour at which the procession of cars was to start, people began to gather in thousands in Old Market-street, and as noon approached the crowd became more and more dense, until the street was thick from end to end with interested spectators. The journey to Kingswood took about half an hour, and when the whole of the cars had reached that end of the line Mr. W. Butler, the chairman of the company, declared the line open. On the way back a halt was made to enable the power station to be inspected.

The guests were afterwards entertained by the tramway company at the Grand Hotel, when, after a well-served luncheon, the usual congratulatory toasts were discussed.

This line should do much to dispel the objections to the overhead system of traction, as the line equipment is an ornament to the thoroughfare.

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ABDANK'S HYSTERESIS COMPENSATOR.*

The researches of Ewing, Hopkinson, and others have shown how greatly the action of iron depends upon its previous magnetic history, and hence when iron masses are employed in electrical indicating and other apparatus these effects of residual magnetism, coming under the more general class of hysteresis phenomena, introduce errors. As a result, indicating instruments of this type have been shunned in the past where accuracy was considered desirable. The simplicity and cheapness of this type of instruments have nevertheless given them considerable vogue, and the most recent attempt to remove the cause of objection to their use will therefore be of interest.

M. B. Abdank-Abakanowicz, of Paris, has just devised what he calls a hysteresis compensator, to effect the desired purpose. This he accomplishes by combining with a magnetic circuit one or more masses of iron or steel, constituting

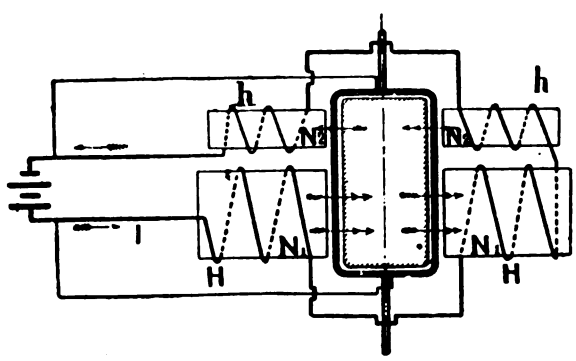
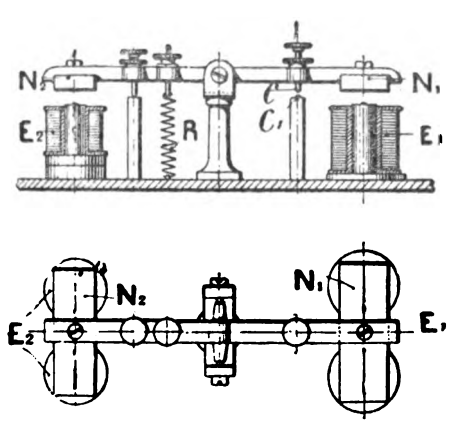


FIG. 1.

what he calls a "secondary differential magnetic circuit," the action of the lines of force of the secondary circuit being opposed to those of the principal circuit. By properly choosing the dimensions of the secondary, with reference to those of the principal magnetic circuit, a differential value may be obtained for all currents within the range of the apparatus which will be proportional to those currents. In other words, the effect of the residual magnetism of the first circuit is neutralised by the residual magnetism of the second.

The accompanying diagram (Fig. 1) shows the application of these principles to a continuous-current wattmeter. The potential is measured by the movable coil, and the current is made to traverse the coils, H, of the principal electromagnet, and the coils, *h*, of the secondary or compensating electromagnet. The core N′, which produces the principal flux, is made of metal having the smallest amount of hysteresis possible, of soft iron, for instance, while N^2, which produces the flux for compensation, is made of cast iron or steel, or



FIGS. 2 AND 3.

some metal having a high coefficient of hysteresis. The double arrows in the diagram represent the directions of the magnetic fluxes, and the single arrows those of the current. By varying the sections of the two cores, N′ N^2, the ampere-turns applied to these cores and the air-spaces of the magnetic circuits, it is possible to make a combination such that the residual magnetism is either entirely or only in part compensated, and that the resultant magnetic flux will be always proportional to the current, in which case the resultant torque of the armature will be proportional to the watts. Practically the same method may be applied to the case of a solenoid acting on a core of soft iron, which core it is desired shall be drawn in by the action of the solenoid to a certain predetermined point when the current shall have attained a certain predetermined value.

Figs. 2 and 3 show the same principle applied to a relay. The principal electromagnet, E′, acts on the soft iron armature, N′, in opposition to the spring, R, and against the action of the differential electromagnet, E^2, and the armature, N^2, which have a high coefficient of hysteresis. The two electromagnets are supposed to be excited by the same current. By choosing suitably the elements of the magnetic circuits of the two electromagnets it is easy to arrive at such a combination as will ensure that the contact between *c c′* will always just take place when the current has attained a certain predetermined value, whatever may have been the previous values of the current. The practical rule to follow in this case is as follows: The attraction due to the residual magnetism of the electromagnet E^2 and of the armature N^2, ought to be equal to the attraction produced by the residual magnetism of the electromagnet E′ and of the armature N′ for the position of contact.

* From the *Electrical Engineer* (New York).

THE JEANTEAUD ELECTRIC CARRIAGE.

Considerable attention is just now being devoted both in France and this country to the question of electric carriages for road work. The convenience of an electric carriage is obvious; its most serious defect is the necessity of returning to the charging station to exchange or recharge the accumulators after a certain distance has been run. The first question then to be determined in constructing an electric carriage is the distance to be run without

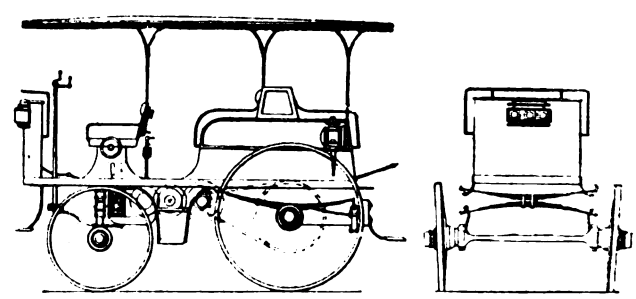


FIG. 1.

recharging and the speed desired. Mr. C. W. Rechniewski, writing in *L'Electricien* of October 3 on the subject of Mr. Jeanteaud's carriage, which recently did the journey from Paris to Bordeaux, says the Fulmen accumulators have hitherto given the best results in this kind of work. The batteries used for the Paris to Bordeaux run weighed 850 kilogrammes complete (between 16cwt. and 17cwt.) and were made up of 38 cells, contained in 12 boxes of three or four cells each. The electrodes of each cell weigh 33lb. and have a capacity of 300 ampere-hours under the ordinary conditions of a discharge spread over 10 hours. At the rate of discharge of 70 amperes, or 2·1 amperes per pound of plate, the capacity of the battery was still 210 ampere-hours. Unfortunately, the adoption of 10 hours as the time of discharge would place a very low limit on the rate of speed. The best speed record for electric carriages belongs at present to Mr. Jeanteaud, who in designing his carriage has departed from the ordinary lines of carriage-building, so that the eye should not at once be struck by the absence of the horses. The carriage (Fig. 1) has two cross seats, each holding two persons, and a third seat at the back, also for two persons. There is a dashboard in front carrying an electric lamp. The accumulators are placed under the hind seats. The wheels are hickory, and are respectively 39½in. and 55in. in diameter. The total weight of the loaded carriage is about 3 tons 3cwt., and is distributed so that the front wheels support 23½cwt. and the rear wheels 39½cwt. Each of the front wheels is independently

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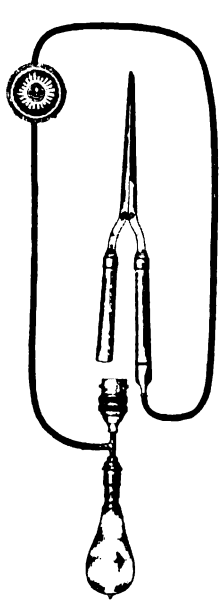
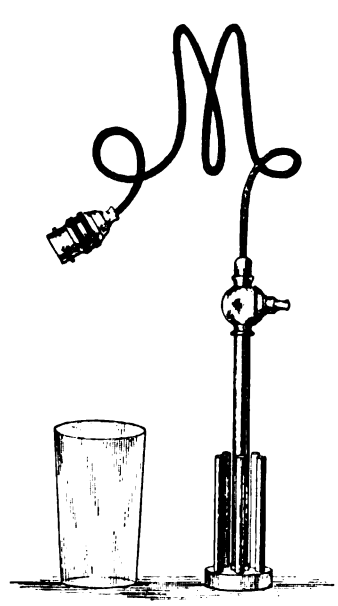
pivoted for steering purposes, which is stated to give great advantages over other methods of steering. Two transverse springs on the fixed axle carry the body of the carriage. The frame is of steel throughout. An accident at starting from Paris bent the rear axle, causing the bearing to heat, and hence necessitating frequent stops for cooling and lubrication. For stopping there is provided a strong brake acting on the naves, and an auxiliary brake worked from either side of the front seat. The wheels are driven by two chains, from a spindle carrying the differential speed gear, giving speeds of from 7 to 15 miles per hour. The change of speed was to have been done by a Bovet magnetic gear, but this not being ready in time ordinary spur gear was substituted. The motor was constructed by the Société Postel Vinay, and has an efficiency exceeding 90 per cent., and at its normal rate is intended to give 7 h.p. at 70 volts. The weight of the motor is about 4½cwt., and it can be made to develop 14 h.p. or 15 h.p. when mounting inclines. For the Paris-Bordeaux run it was arranged that only the steering should be done by the conductor, the driving apparatus being managed from the second seat. This includes reversing gear and switches for the accumulators, and for separately exciting the field magnets, so as to maintain the same speed down hill as on the level. This was found exceedingly useful, the motor acting as a brake, and under certain circumstances delivering back a current of 80 amperes to the accumulators. Practically, however, the amount of the current so restored was not worth taking into account, but the regulation of the speed down hill was perfect. On the other hand, at slow speeds only portions of the accumulators were worked. A fresh set of accumulator cells, weighing 16½cwt., was required after about 25 to 44 miles traversed, according to the gradients. For charging the accumulators a stoppage of 10 minutes was required, the connections being made automatically by springs and plates. The construction of the vehicle was only begun three months before the Paris-Bordeaux competition, and it is stated that the object of Messrs. Jeanteaud and Brault, the designers, was not so much to gain the prize offered as to show that electric road carriages were already a practical success. Mr. C. W. Rechniewski considers that this was fully realised.

HOUSEHOLD ELECTRICITY.

Some years ago it was customary for popular writers to portray the many uses to which electricity might be put. By its aid we were to clean our boots, brush our hats, and, in fact,



Electric Curling-Tongs.

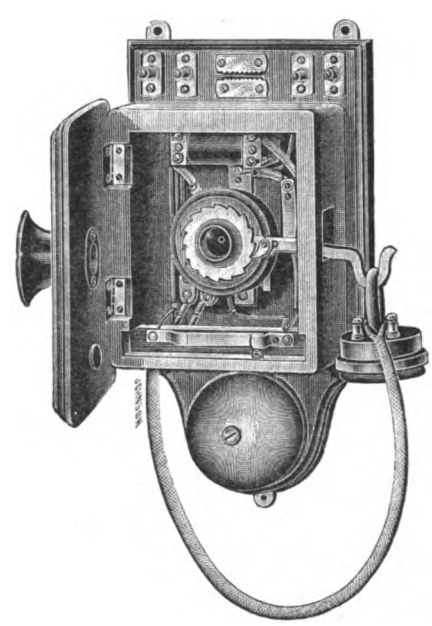


Electric Heater.

carry on all manner of household business. Many of the suggestions then made are in a fair way of being realised, and the more of these handy little household utensils are put upon the market the better it will be for electricity. One of the dreaded pests in a house is that portable hair-curling apparatus which burns methylated spirits. Now, whatever house contains electric lamps can be fitted with less dangerous and more cleanly apparatus of the kind. We herewith illustrate the curling-tongs patented by Mr. March, and which to the eyes of the sterner sex seem far more cleanly and far better adapted for their work than the old fashioned tongues. They can be attached to any lamp-holder. The temperature can be kept uniform as long as required. There is no waiting for the tongues to be heated so that the toilet operations can be carried on without delay. Another apparatus introduced by Mr. March is a small electric heater designed to be put into the fluid to be heated, so that there is no waste of heat. The apparatus is silver-plated and easily cleaned, so that objections on the part of uncleanliness can hardly be made. So far as we have seen, both these pieces of apparatus are admirably adapted for the purpose for which they are to be used. The heater is small enough to go into an ordinary tumbler. The illustration explains itself.

GENT'S AUTOMATIC REVOLVING TELEPHONE TRANSMITTER.

In transmitters of the granulated carbon or Hunnings variety, the carbon is apt to cake or wedge at the bottom, and speaking is thereby much impaired. To overcome this, instruments with revolving transmitters were some time ago put on the market, the purpose being that by giving a half-turn or so to the mouthpiece, which was fixed to the microphone or transmitter case, the carbon might be shaken up and speaking rendered clearer. That this is a necessity is proved by the fact that the Hunnings instruments adopted by the Post Office are so fitted.



Even if one always thought of it, it is somewhat troublesome to have to give the mouthpiece a turn before speaking; and to obviate this, Messrs. Gent and Co., of Faraday Works, Leicester, have brought out an instrument in which the transmitter is automatically revolved. The arrangement is shown in the figure, and it will be clear that the microphone case is moved round a little every time the receiver is taken off its hook. In another form, this automatic rotation is performed not by the switch-hook, but by the ringing key. W. Perren Maycock.

Harrogate.—The Electric Lighting Committee have accepted the following tenders: Lancashire boilers, economiser, feed pumps, and accessories, Holdsworth and Sons, Leeds-road, Bradford, £1,516 (without brickwork settings, etc.); steam alternators, condensers, fittings, etc., steam, exhaust, feed, and sundry pipes, valves, etc., Ferranti, Limited, Charterhouse-square, E.C. £7,428 (125-unit plants in place of 100-unit plants); switchboards and instruments, Ferranti, Limited, £671. 3s; high and low-tension mains, British Insulated Wire Company, Prescot, £2,931. 1s. 6d.; transformers and accessories, Brush Company, Queen Victoria-street, E.C., £403. 7s.; overhead travelling cranes, Southgate Engineering Company, Fenchurch-street, E.C., £190. There were in all 57 tenders received.

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THE GIANT'S CAUSEWAY ELECTRIC RAILWAY.

The following statement has been forwarded to the Board of Trade, on behalf of the Giant's Causeway Electric and Tramway Company, by Mr. A. Traill, chairman of the company :

The directors wish in the first instance to remind the Board of Trade that this has been the pioneer of electric railways, being the first constructed for commercial purposes in any part of the world. It is scarcely, therefore, to be expected that it should have escaped the misfortunes, experimental or other, which necessarily accompany the early stages of a new invention. Both the Board of Trade and this company have been to a great extent groping in the dark for a number of years, and the responsibility for any mishaps which may have occurred to animals must be shared by both, and the company are quite as anxious as the Board can be to devise any further arrangements as may be proved necessary for the greater security of life and property. The directors, however, hope that the Board will not yield so far to unreasoning panic as to involve the company in unbearable expense. The directors are prepared to admit, as the result of the evidence at the recent enquiry, that a current of low pressure of 250 to 300 volts can no longer be considered safe for the lower animals, but they are equally satisfied as the result of constant experience for more than 12 years that such a current by mere contact is not dangerous to human life. Overwhelming evidence to that effect was produced at the recent enquiry. While it is admitted that animals were killed by the electric current, generally from long contact with the rail, the directors cannot admit that the young man Walne was so killed, and they ascribe his death to the fall from the bicycle, in the absence of any *post-mortem* examination from which the actual cause of death could be ascertained. Even in regard to animals, it is remarkable, after all, how few cases of death have occurred—nine in 12 years, though when brought forward together the array looked formidable. It should be remembered that there have been hundreds of cases of contact which have not proved fatal, even to animals. It is remarkable that the fatal cases have all occurred in wet weather. A current, which on a dry day is almost imperceptible, seems suddenly to become dangerous to animals, when everything is soaked in wet. It is, however, also remarkable that in all these cases of death of animals there was contributory negligence by the owners. The directors thought it to be a wise and just policy, though not legally liable for damages, to pay liberal compensation to persons whose animals were injured, even though they had contributed by their negligence to the result, but they never hesitated to resist extortionate claims.

In relation to the recent loss of life by Mr. Walne, the bicyclist, the directors wish to call the particular attention of the Board of Trade to the evidence produced on behalf of the company. It was shown that drunken persons had been repeatedly in contact with the rail for considerable periods and in all weathers, without any injurious effects ; that workmen employed on the line and about the rail were constantly touching the rail, one man in particular (Boyd) having been for 15 minutes in a cramped position effecting repairs under a car, with his head and neck touching the rail, and a current passing through him for all that time ; that hundreds of persons, tourists and others, were constantly taking electric shocks, from curiosity or for amusement, while some used the current for medicinal or surgical purposes. With this evidence constantly before them, it was impossible for the directors to come to the conclusion that any danger could arise to human life, but none could expect them to have made provision against the extraordinary case of a young man riding rapidly along the public road, suddenly turning his bicycle against the raised kerbstone of the footpath in order to get up on that path, then turning a somersault through the air over the head of his bicycle for a distance over 6ft., lighting with his head against the fence and his arms beyond the rail, and his chest against it. A stone wall in a similar position would be quite as dangerous to a bicyclist getting a similar fall, and yet the road authorities are not expected to make provision for the safety of the public against such accidents. Bicyclists are being constantly killed by falls not as severe as this one, and yet it seems to be assumed by many that it was not this fall that killed him, but the shock from the electric current. In proof of this much stress was laid upon the fact that there were superficial burns upon Mr. Walne's chest. It is quite natural in the present state of knowledge, or rather want of knowledge, of the nature of death by electricity that persons who are totally ignorant of such matters should jump at once to so easy and natural a conclusion ; but the Board of Trade will know that in all cases of shocks from electricity which have been recorded the person, if not killed at once, gradually got better till he recovered from the effect of the shock, while in the case of Mr. Walne it was distinctly proved that he was not killed on the spot, that he was able to swallow brandy, and knew what he was then doing, and that instead of gradually coming out of the shock, he got worse and worse until he died, about half an hour afterwards. This points more clearly to some lesion of the brain or heart arising from the fall, than to death from an electric shock. With regard to the burns on his chest, they were quite superficial, and of small extent ; a florin would have covered the only one of any size. A spark passing from his soaking wet clothes to the skin, on his making and breaking the contact, while struggling on the rail, would have caused these burns, and it was proved at the enquiry that a girl in contact with the current got her hands severely burned from a like cause, without any fatal or serious results.

The directors wish to point out that the verdict of the jury at the coroner's inquest states, in accordance with the evidence of the doctors, that the young man died of shock, but the words "electric shock" were carefuly excluded. The shock was twofold, from the fall and from the electric current. That from the current alone would certainly not have killed him, because at that hour, with only one car on the line, the pressure of the current was necessarily low. The shock from the fall might or might not alone have killed him, but it is remarkable that the blow which he received on the chest on striking the rail was proved to have been exactly on that spot, the ensiform cartilage, which is known to be dangerous, the very spot where it is on record that a man has received a fatal blow at a prize fight. In the absence of a *post-mortem* examination it appears to be a reasonable inference that however the electric current may have been accessory or otherwise towards the prevention of his recovery from shock caused by the fall, it was the fall from the bicycle which was the primary cause of death. Since the enquiry a case has come to the knowledge of the directors of a similar accident to a bicyclist, who can be produced, who was thrown on the electric rail without receiving any serious injury.

In conclusion, the directors wish to call the attention of the Board of Trade to the strong claim the company have on the sympathy of the general public in their great undertaking, and the interests of 100,000 travellers yearly to the Causeway must be taken into consideration, as well as those of a few local owners of cattle. Anyone who remembers this district 13 years ago will know that the Giant's Causeway, though well known by repute all over the world, was visited by but few, and those mostly tourists. It was but little known to the mass of people, the working classes of this country. Five thousand visitors in the year would be an over-estimate for the years before 1883. In that, their first year, this company carried some 54,000 persons. That number has gradually and steadily increased year by year, until in 1894 it reached the large number of 93,000, and this year the number will almost certainly exceed 100,000. A rare boon has been opened up for the working classes of the North of Ireland. A man can leave Belfast by early train for Portrush, travel over this line, get four or five hours at the Giant's Causeway, and get home comfortably the same evening for the sum of 3s. 6d., of which this company gets 1s. Simultaneously with this, there has been a great increase in the size and population of Portrush. There has latterly been an annual increase of £400 or £500 a year in the valuation of the town, and with a winter population of 1,600, the summer population comes up to some 6,000 persons. With the addition of one of the finest golf grounds in the United Kingdom, this whole district has become completely opened up, and money has been freely poured into the country. The directors claim that this company has been the pioneer of all this progress.

Owing to the expense of steam, and the smallness of the number of travellers in the winter months, the line has been hitherto worked during that part of the year entirely by electricity, and the directors hope that whatever arrangements the Board of Trade may think it necessary to require for the full working by electricity in the future, they will agree to allow sufficient electricity to be used during the ensuing winter to drive a single car without a trailer. When the voltage for this purpose had been defined, a volt-cut-off at the waterfall will provide against any excess of pressure being used. In addition, the directors will be prepared to make any reasonable compensation, just as they have hitherto done, in the case of any animals accidentally injured, due allowance being made in respect of contributory negligence by the owners.

PLYMOUTH.

The following is the report to the Electric Lighting Committee of the Corporation of Plymouth by Dr. J. A. Fleming, F.R.S. :

In accordance with the request conveyed to me by your town clerk (Mr. Ellis), I have collected together in this report such information and data with regard to municipal electric lighting as will, I trust, enable you to form decisions on the question of the electric lighting of Plymouth, and have to this added my own opinions and the advice I beg to tender you thereon. I was requested to advise (1) on the electric lighting generally of Plymouth by the Corporation ; (2) on the utilisation of town refuse as fuel ; (3) on the employment of electric traction in connection with tramcars in Plymouth.

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TWENTY-SIX ALTERNATE-CURRENT ELECTRIC SUPPLY STATIONS ESTABLISHED BY CORPORATIONS OR LOCAL AUTHORITIES.

Town.	Lamps connected 8c.p. or equivalent.	Price of Board of Trade unit for night or light supply.	Price of gas in district. s d.
Bedford	2,400	6d.	3 3
Blackpool	8,000	6d.	2 6
Bolton	4 100	5½d. to 8d.	3 2
Brighton (partly)	38,000	7d. and 3½d.	3 1
Bristol	14,200	6d.	2 8
Burton	4,000	6d.	3 0
Cardiff	700	6d.	2 10
Derby	7,880	6d.	2 8
Dublin	16 600	7d.	3 6 to 4 0
Ealing	4,000	6d.	3 3
Halifax	5 800	6d.	2 2
Hanley	8,000	6d.	2 6
Huddersfield	16,000	6d.	2 9
Kingston-upon-Thames	3,590	6d.	2 11
Portsmouth	12,600	6d.	2 4
Southport	3,500	7d.	3 3
Taunton	4,000	6d.	4/6 less dis. 3/9
Worcester	—	5d.	2 9
Yarmouth	1,020	6d.	3 2
Cheltenham	—	6d.	2 4
Coventry	—	6d.	2 8
Edinburgh (partly)	10,000	6d.	3 9
Newport (Mon.)	—	6d.	3 0
Salford	—	7d.	2 4
South Shields	—	—	2 6
Sunderland	—	6d.	1 6 to 1 11

TWENTY CONTINUOUS-CURRENT ELECTRIC SUPPLY STATIONS ESTABLISHED BY CORPORATIONS OR LOCAL AUTHORITIES.

Aberdeen	7,250	7d.	3 5
Bradford	28 500	5d.	2 3
Brighton (partly)	38 000	7d. and 3½d.	3 1
Burnley	6,000	6d.	3 0
Dewsbury	813	6d.	3 0
Dundee	12.000	5d.	3 4
Glasgow	60,000	6d.	2 6
Hull	13,600	6½d.	2 0 and 3 0
Lancaster	4,000	7d.	2 6
Londonderry	*	—	3 10
Manchester	60,520	8d.	2 6
Nelson	3,500	5d.	2 9
Nottingham	7,000	6d.	2 4 to 2 6
Oldham	5,300	6d.	2 4
Whitehaven	4,400	30s. and 2d. or	3 6
Belfast	3,500	— [5d.	2 9
Blackburn	3,000	7d.	3 7
Edinburgh (partly)	10,000	6d.	3 9
Stafford	—	—	2 7
Walsall	—	—	—

* Street-lighting only at present.

TWENTY-THREE ALTERNATE-CURRENT ELECTRIC SUPPLY STATIONS ESTABLISHED BY COMPANIES.

Bath	7,900	6d.	2 6
Bournemouth	18 000	8d.	3 6
Bray	1,834	8d.	4 9
Cambridge	11,643	7d.	2 10
Carlow	1,500	—	5 0
Chelmsford	2,500	1s. and 6d.	3 6 and 4 1
Coatbridge	3,493	5d.	3 4
Eastbourne	9,000	9d.	3 2
Exeter	6,000	6d.	3 1
Fareham	1,000	8d.	3 9
Hastings	—	9d.	3 9
Keswick	2,000	—	3 3
Larne	300	8d.	4 2
Leeds	17,000	6d. to 7d.	2 4
Lynmouth	1,200	—	—
Newcastle-on-Tyne	24,000	4½d	1 10
Newcastle-on-Tyne	21,000	6d.	1 10
Reading	3,200	8d.	3 0
Scarborough	11,038	5½d. to 6½d.	2 10
Sheffield	20,726	6d.	2 2
Weybridge	800	9d.	4 9
Woking	3 000	8d.	5 0
Dover	1 700	8d.	2 6

FIFTEEN CONTINUOUS-CURRENT ELECTRIC SUPPLY STATIONS ESTABLISHED BY COMPANIES.

Birmingham	26 500	8d.	2 7
Buckingham	900	7d.	5 0
Galway	1,600	5d.	5 6
Hove	15,808	8d.	2 9
Kelvinside	4,000	6d.	2 6
Leamington	4,900	8d. and 4d.	2 9
Liverpool	45,000	7½d.	3 0
Morecambe	3,000	7d.	3 11
Northampton	4,600	8d.	2 4
Norwich	—	8d. and 4d.	3 8
Ogmore Valley	1,400	6d.	—
Oxford	11,000	8d.	3 4
Preston	11,500	7d.	3 7¾
Southampton	4,000	8d.	2 10—3 4
Thetford	1,800	6d. and 7d.	5 0

It may be useful to preface other remarks by a short statement of the present state of electric lighting in the United Kingdom.

PRESENT CONDITION OF ELECTRIC LIGHTING IN THE UNITED KINGDOM.

Leaving out of account London, there are at the present time (1895) some 82 towns in the United Kingdom in which a public electric supply is given, or about to be given, either by the local authority, corporation, or by a limited company. Of these stations 47 have been established by municipal authorities, and 35 by limited companies. Broadly speaking, the electric supply is being given in each place by one or both of two systems—viz., either by the alternating-current system or by continuous-current system. The alternate-current stations are generally called high-tension stations, because the electric current is generated in them at a high pressure (about 2,000 volts), and then reduced down to a low pressure (100 volts) for use in the houses by transformers either placed in the buildings, or in special transformer sub stations. The continuous-current stations are generally called low-tension stations, because in them (with the exception of Oxford and one or two other places), the continuous current is generated at a low pressure (110 or 220 volts) and supplied to the consumers direct without transformation. The capacity of an electric station is popularly estimated by stating the number of 8-c p. incandescent lamps it can supply, or which are connected to it. It is more exactly estimated by starting the safe or effective output capacity of the dynamo plant in kilowatts.

A classified list of the 82 provincial electric supply stations of the United Kingdom is given herewith, divided so as to show: (1) stations established by local authorities on the alternating-current system; (2) stations established by local authorities on the continuous-current system; (3) stations established by companies on the alternating-current system; (4) stations established by companies on the continuous-current system, with the approximate present lamp connection of each place, the price at which the electric energy is sold per Board of Trade unit, and the price of gas in that place. These figures were correct at the end of the year 1894, but progress is so rapid in some towns that they are in many cases already antiquated. They will serve, however, as a general indication of the state of electric lighting in 1894.

It will not be necessary to enter into a detailed technical description of these two principal methods of electric supply. Suffice it to say, that in places where the demand for electric light is concentrated, and where the supply station can be placed in the midst of, or at no great distance from, the centre of the area to be lit, it has been found advantageous to adopt the system of continuous-current supply, with or without the assistance of accumulators. In this system the generating machines send electric current directly into the supply mains, and the consumers draw off their supply directly from these conductors. If the area of supply is large, or the demand scattered, or the supply station can be most conveniently situated at a distance from the area, then it has been found best to adopt the system of alternating-current supply, in which the current is generated at a high pressure of about 2,000 or 2,400 volts, and it is sent to certain sub-stations in which are placed appliances called transformers. These transformers generate from the currents of high pressure, called primary currents, other currents of low pressure at 100 or 110 volts, called secondary currents, and these last are distributed to the houses of users and to the other buildings to be lit. The alternating-current system has the advantage that small detached areas of supply are more easily served, and pioneer work in the outskirts of the main area of supply in a town is easily carried on by means of transformers placed in the houses. Many considerations have to guide the engineer who is called upon to make a recommendation as to system, and, whilst in the generality of cases there can be no little difference of opinion as to the choice to be made, there is in others some difficulty in making the right selection.

The list of municipal electric light undertakings shows, however, that the public supply of electric current is no longer a matter on which the slightest room for doubt as to its practical success can exist. The results of the last five years' experience have also been to show that the advantages to the local authority in retaining the public supply of electricity in its own hands are very great. In many cases in which supply companies have built up a solid business, such as in the towns of Liverpool, Bath, Southampton, and other places, the corporation or local authority are now feeling the necessity for acquiring it, and will generally have to pay more for it than it cost in the first instance to establish it.* It may therefore be remarked that it is advantageous that in Plymouth there is no electric lighting company in present possession, and requiring to be bought out, but a clear field exists for establishing a corporation electric station on the best lines. The experience gained in the last five years or more of the financial results of working shows that the business of public electric supply can be carried on with a profit which is not only sufficient to repay the loan and meet current interest, but which affords a prospect of making a further margin of profit to the advantage of the town. The experience generally has been that the first year of working is sufficient to place the undertaking in a position to pay its outgoing expenses, and that from and after that time increasing contributions are made to the loan repayment and interest fund.

* Since the above paragraph was written, the Corporation of Liverpool have purchased by valuation the plant and business of the Liverpool Electric Lighting Company for £400,000, a sum greatly in excess of the original first cost of the undertaking.

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System Suggested for Adoption at Plymouth.

After carefully considering the present and probable future requirements of Plymouth in the matter of electric lighting, and viewing the site by the Cattewater suggested for an electric station, I am of opinion that the conditions indicate as most suitable for the district the adoption of an alternating-current supply system with transformer sub-centres. I consider that the Cattewater site, a property owned by the Corporation, is well adapted for the establishment of a Corporation electric supply station on this system. In this position several advantages will be gained. In the first place, there is access for coal delivery both by rail and by water; in the next place, water can be obtained for condensation; and, lastly, the station is removed from the residential portion of the town. If on other grounds it is desirable to establish a refuse destructor, as subsequently discussed, it can, without risk of nuisance, therefore, be placed on an adjacent site.

In the selection of the precise spot for the station, regard should be taken of the fact that, unless directly against the waterside, some expensive works may be necessary to bring in condensing water. Hence, since the Cattewater is a tidal inlet, it will be necessary to consider the exact position of the station with some care, and also it will, I think, be necessary to construct a quay or wharf, on which part of the station can be situated, at which wharf coal barges can discharge and easy access for condensing water be obtained. The general design for the station should be a building divided into engine-room and boiler-house, placed to as to be extended gradually from the waterside as required. The coal-store should lie between the railway and the wharf, and delivery of coal must be made without handling, a locomotive crane unloading from barge or railway truck into the coal-store direct. The important matter is to design the building in the first instance so that subsequent extension of the station may take place as required, without alteration or interference with the section already constructed.

The position on the Cattewater site will permit surface condensers to be employed, using the water of the Cattewater for circulating and returning the condensed water to a hot-well A considerable economy in coal will be effected by the employment of condensation. The chimney-shaft should be constructed at once large enough for the full output of the station. The station building should, in my opinion, be designed for an ultimate output equal to 30,000 8 c.p. lamps, but only about one third of the station erected at first, and provision made in the initial building in generating plant at first only for 7 500 8 c.p. lamps operated at one time or for about 10,000 lamps connected to the mains, with proper reserve plant. Although we may reckon an 8 c.p. lamp as taking about 32 watts, it is safe to make provision in the generating plant for 40 watts per 8 c.p. lamp This lamp load of 7,500 lamps at the safe reckoning of 40 watts generated per lamp corresponds to a working capacity of 300 kilowatts, or 400 with reserve plant. As regards the size of a unit of generating plant, I advise the adoption at first of one not larger than 75 or 100 kilowatt size, the corresponding engine being about 150 h.p. or 200 h.p. The alternators or dynamos should be direct-driven, as at the Portsmouth or Leicester Corporation stations—that is, no belts or ropes employed. These alternators should generate current at a pressure of 2,000 or 2,400 volts. The current should be transmitted by armoured concentric cables laid direct in the ground to transformer sub-stations, established in various parts of the town and where it will be reduced in pressure to 100 volts for distribution to the houses. These transformer sub stations will be small rooms, or dry cellars, which may be situated beneath buildings, or may be small separate underground chambers, in which the transformers will be placed. The distributing mains will be laid under the pavements on either side of the road, and from them the house services taken off. I should suggest the adoption of a plan I have carried out successfully at Taunton, where no junction-boxes are used at all, and hence no receptacle for the collection of gas, and therefore no risk of street-box explosions. This plan consists in making at once when the distributing cables are laid down a connection or service to every house.

The distributing mains are formed of concentric lead-covered and steel-armoured cable laid under the pavements, and are quickly laid, and give no trouble. I have considered very carefully the question of supply of electric current for power to private houses, shops, and places of business. As gas in Plymouth has a low price, the supply of electric power will have to compete against gas-engines served with cheap gas. I think that this may act to retard the growth of a demand for current for power in the daytime, and it has not been found that the sale of power in small units has progressed very fast in any of the provincial towns. If, however, further enquiry shows the necessity of meeting any demand for power in small units which cannot be met more cheaply by gas-motors, then I should suggest for adoption in this case a two phase alternating-current system, by which current, not only for light, but for power, can be distributed, if required. As regards the frequency of alternations my own strong preferences are for a moderate frequency, such as 50 periods per second, which has been adopted with success at Portsmouth, Ealing, and Derby.

The current would be brought from the electric station on the Cattewater to the transformer sub stations. One of these last might be placed in a cellar under the market, and from this one sub-centre all the compulsory street area in George street, Bedford-street, and Old Town-street could be lit. Service lines should be laid down on both sides of these streets, and a supply given in other neighbouring streets, if required. As regards a day supply, I strongly urge that it be not given at first, but that the electric service be only from dusk to dawn, as it is found by experience that in the initial stages of the business very great economy is effected by not adopting a 24-hour service. With respect to systems of charge it is very important to remember that electric supply differs in important particulars from gas and water supply, and the difference may be summed up as stated below in an extract taken from a report given by me to another corporation.

"In dealing with a public supply of electric current it has to be borne in mind that the conditions under which such a work is carried out are very different from the supply of such commodities as water and gas. Every lamp installed in a consumer's place has to be represented in the supply station by a certain amount of plant which is capable of providing electric current for that lamp at any time from sunset to sunrise; but the actual time during which a lamp is in use is a very small fraction of the time during which it might be in use. The value of a consumer to the electric supply station is not determined solely by the number of units he takes, nor by the number of lamps which he has installed, but by the average length of time which he uses the lamps he has in place The actual amount, therefore, of a consumer's bill is then no indication of the commercial value of that consumer to the supply station.

"Take, for instance, the case of two consumers, one of whom has 100 lamps installed in his shop, but who only uses them at an average of one hour per day for 300 days in the year, the amount taken by this customer during the year would therefore be 1,800 units, which at 6d. per unit is £45. Suppose, however, that another customer has only 25 lamps installed, but uses them at an average four hours per day; his bill during the year will be precisely the same as that of the first customer, but whereas the first customer requires the generating station to put down plant representing the possibility of a supply for 100 lamps, the second one only makes a requirement for 25 lamps in plant. The whole expenses of working the generating station may be divided into two parts. The first part comprises what may be called the fixed charges, which are the establishment charges for superintendence, interest on borrowed capital, and other items which hardly vary at all with the amount of the electrical energy sent out from a given electrical plant.

"In the second place, there are the variable charges, such as those for coal, oil, water, and engine-room stores, which vary almost proportionately with the electrical output of the station. Hence, it is clear that to make ends meet there must be, in the first place, a certain minimum of units made and sold, but that when these are bought and paid for every succeeding unit can be supplied at a very much less price, still allowing a margin for profit. The important question, therefore, in the commercial management of the station is this: How can we encourage those consumers who are taking the units which can be cheaply produced? This is not achieved simply by giving discounts on the total bill, because, as explained above, two consumers may have exactly equal bills, and yet one of them may have made a profit to the electric lighting station, and the other of them may actually have made a loss. This question has taxed the mind of every electrical engineer. A solution of the difficulty has been proposed by Mr. Wright, of Brighton, who has invented what he calls a demand meter. This demand meter is fixed in the consumer's house and it shows, not the total units taken by the consumer, but the average time during which a consumer has used the lamps installed in his house. A discount is then given on this basis: thus, for instance, at Brighton, every unit which is taken by the consumer for lamps burning less on an average than one hour per day is charged 7d, but all units taken by consumers for lamps which on an average burn more than one hour per day are charged 3d. per unit. In this way an encouragement is given to long hours of use, and a consumer has it in his power to moderate the charge to him by a use of the incandescent light, which effects an economy in the cost of production. Since this method of charging has been in force in Brighton the total consumption of units has increased fourfold in two years."

My recommendation on the subject of charge is that the full price in your order—viz. 8d. per unit—should be charged for the units supplied to all lamps which burn one hour or less per day, but that a reduction of 4d. per unit be made for all units supplied over and above the one hour per day for such lamps. At this rate the cost of current for an 8-c.p. 32-watt lamp used one hour a day on an average would be 7s. 9d. per annum, but if used two hours per day on an average the cost would be only 50 per cent. increased, and would be 11s. 8d. per annum.

Public and Private Lighting.

I hold the view very strongly that whenever a Corporation undertakes the electric supply, good street-lighting should form part of the scheme. Every ratepayer has an equal interest in good and well-arranged public lighting in the streets, and the adoption of a system of arc and incandescent lighting for the streets is, I consider, an essential matter. As regards the arc lighting plant, there is strong evidence in practice that arc lighting to be effective and economical must be conducted with continuous currents. If alternating currents are adopted for the private incandescent supply, then either separate arc light dynamos must be provided, or else, as at Portsmouth and other places, a device called a rectifier for converting part of the alternating current into direct current for the arc lighting.

The arc lamps should be carried on ornamental cast-iron poles and be placed alternately on either side of the street about 35 or 40 yards apart, or closer if the street lit is not moderately straight. The conductors for the arc lamps should be underground and consist of twin-armoured cable. The arcs should be on several separate circuits to avoid risk of simultaneous extinction. Side streets can be lit with series incandescent lamps off the arc light circuits.

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I am strongly of opinion that arc lighting in the streets, squares, and on the Hoe should form part of any municipal scheme for electric lighting in Plymouth, and that such arc lighting should be conducted by what is called the series system with continuous currents, the currents being supplied either by separate arc lighting machines, direct driven, or by rectified alternating currents. I will not at the present moment commit myself to an opinion as to which of these methods should be selected, as it will, to some extent, depend on the tenders, but by either system it is possible to provide perfectly satisfactory public arc lighting, and the smaller streets can, if need be, be lit by incandescent lamps running in series with the arc lamps, and arc lights provided for the outside of public buildings.

Any interior arc lamps required would have to be alternating-current arc lamps, as the introduction of the high-tension current into buildings is not regarded favourably by the Board of Trade The cables for this arc lighting system should be armoured cables placed underground—the arc lamps being supported by ornamental cast-iron posts placed at the distances mentioned—the arc lamps being those which are termed 300-watt arcs. There is not the slightest doubt but that good arc lighting would form a great additional attraction to the public resorts in Plymouth.

(To be continued.)

COMPANIES' MEETINGS AND REPORTS.

WESTINGHOUSE ELECTRIC COMPANY, LIMITED.

The fifth annual general meeting of this Company was held on Tuesday last at the Company's offices, 32, Victoria-street, S.W., to receive the report and balance-sheet for the year ending September 30. The proceedings were formal, and the Press were not admitted. The report states that "the agreement between the English and American companies approved by the shareholders at the last general meeting has been carried out. After providing for all expenses of management, directors' fees, depreciation of stock and office furniture, patent taxes, and other expenses connected with the maintenance of the various English and foreign patents owned by the Company, there is a net profit for the year amounting to £7,725. 1s. 11d., which, added to the sum brought forward from the previous accounts, makes a total of £20,739. 18s. 7d. to the credit of profit and loss, which the directors propose to carry forward. Owing to the continued increase in the sales of the Shallenberger meter, the directors have found it necessary to provide more extensive laboratory accommodation, for the purpose of ensuring careful tests and adjustments of the meters being made before despatching them to purchasers. The sales of meters during 1894 have been satisfactory, and orders for transformers and other apparatus were also in excess of those of previous years. The directors have, as before, waived their right to one-half of the fees to which they are entitled under the articles of association. Mr. Oscar H. Baldwin, who was previously associated with the English company, has returned to London, and, on the recommendation of Mr. Westinghouse, has been appointed manager of the Company with a seat on the Board." The directors add that they "think the shareholders will be glad to know that they have purchased a controlling interest in the European patents, covering a new system of electric traction in which the conductors are placed underground, and which they believe will prove to be a very valuable asset."

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ashington.—Tenders are desired for the electric lighting of Miners' Hall, Ashington. Names and addresses should be sent at once to Messrs. Boolds and Hardy, architects and surveyors, Morpeth.

Madrid.—The Director of Public Works invites tenders by November 15 for the concession of the construction and working of a tramway from Madrid to Colmenar Viejo, with branches to Chamartin and Rosa. Security, 12,505 pesetas. Particulars at the Direccion General de Obras Publicas (Ministerio de Fomento), Madrid.

Saltash (Cornwall)—Tenders are wanted for lighting with gas, electricity, or otherwise the public lamps in the borough from January 4, 1896, for such term as may be agreed upon, for the Saltash Town Council. Number of lamps 81, with every prospect of the number being considerably increased at no distant date. For particulars apply to the chairman of the Works Committee, Mr. W. V. Alford, 3, Springfield-terrace, Saltash, to whom sealed and marked tenders should be sent by 26th inst.

Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

London, E.C.—Tenders will be received at the General Post Office, London, E.C., until noon on 28th inst. (a) for supply of red fir telegraph poles, to be delivered in London, King's Lynn, or Sutton Bridge, and at Northumberland Dock (River Tyne), West Hartlepool, Hull, or Grimsby; and (b) for creosoting the poles with 10lb. or 12lb. of creosote to the cubic foot, as may be directed. The poles to be felled between November 1, 1895, and February 29, 1896, and to be delivered during the following summer at the port at which the creosoting is to be performed. Butt sections, from not less than three poles, to show the quality of timber offered, must precede or accompany the tender of any person who has not already supplied the Postmaster-General with poles. Forms of tender, containing all particulars, may be obtained on application to Mr. Chas E Stuart, controller of stores.

Glasgow—The Corporation desire tenders for the construction of a new line of tramways, commencing at the termination of the existing line of tramways at Rockvilla, and terminating at Saracen Cross, Possilpark; also tenders for electrically bonding the rail joints of the above tramways, for the Corporation of Glasgow. Specifications and forms of tender may be had from Mr. John Young, general manager, 88, Renfield-street, Glasgow, where drawings may be seen and any information obtained. Separate sealed tenders marked "Tramways—Tender for Possilpark Extension" and "Tramways—Tender for Rail Bonding," respectively, to be lodged with Mr. J. D. Marwick, town clerk, City Chambers, Glasgow, by 10 a.m. on 22nd inst.—The City Improvement Trustees are prepared to receive tenders for providing and fitting all the lamps, wires, etc., for lighting the new family home in St Andrew-street by electricity. Specifications and forms of tender may be had from Mr. William Arnot, electrical engineer, 75, Waterloo-street, Glasgow, and tenders must be sent in to the town clerk, City Chambers, Glasgow, by the 21st inst.

RESULTS OF TENDERS.

London, S.W.—The Metropolitan Asylums Board have placed with Messrs. Muirhead and Co the contract for the supply and fitting up, under the supervision of Dr. Hopkinson, of certain additional telephones at the new blocks of the Gore Farm Hospital. The amount is £72.—Subject to the consent of the Local Government Board, the same authority have accepted the tender of Callender's Bitumen Telegraph and Waterproof Company, Limited, to supply and lay two new cables for the electric light installation at the hospital ships, in accordance with a specification prepared by Dr. Hopkinson, at the sum of £125. Messrs. Callender undertake to recover four damaged cables at their own expense, and to allow the managers at the rate of 5d. per pound for the copper.

London, E C—Tenders to the Shoreditch Vestry have resulted as follow: (Section A) insulated electric mains; (B) conduits and drawing-in boxes, to be laid in the parish of Shoreditch. Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, engineers: British Insulated Wire Company, Prescot, (for A and B), for high-tension wires and larger low-tension mains and for conduits (accepted); W. T. Glover and Co., Manchester (for A only), for smaller high-tension mains (accepted) Also tendered: India Rubber and Gutta Percha Company, Silvertown (for A and B); Fowler, Waring, and Co., North Woolwich (for A and B); Henley's Telegraph Construction Company, North Woolwich (for A and B); Callender Company, 101, Leadenhall-street, E C (for A and B); Siemens Bros. and Co, 12, Queen Anne's gate, Westminster (for A and B); Reed Bros., 12, Wharf-road, City-road, N. (for B only). At schedule prices.

Stafford.—The tenders for wiring and fitting the infirmary for electric light, for the Committee of the Staffordshire County Infirmary, were as follow:

Drake and Gorham, 66, Victoria-street, London (accepted)	£397	0	0
Bennett and Druce, 80, Winckley-square, Preston	319	0	0
Lomax, Kendal, and Co., 2, St. James's-square, Manchester	380	0	0
Paterson and Cooper, Victoria-street, London	381	10	0
Liverpool Gas Fittings Company, Duke-street, Liverpool	434	0	0
S. J. Waring and Sons, 118 and 120, Deansgate, Manchester	455	0	0
Corporation of Stafford Electricity Works, Stafford	491	15	3
Lea, Son, and Co., Pengwerne Works, Shrewsbury	442	0	0
F. W. Ball and Co., 3 Unity-street, College-green, Bristol	468	6	0
Strode and Co., 48, Osnaburgh-street, London, W.	500	0	0
Fowler, Lancaster, and Co., Graham street, Birmingham	475	0	0
Northern Counties Electrical Construction Company	586	10	0
Walsall Electrical Company, 57, Bridge-street, Walsall	523	15	0
T. S. Anderson, Royal Insurance Buildings, Sheffield	550	0	0
Fletcher, Hirst, and Co., Bankfield Works, Burnley	566	0	0
Laing, Wharton, and Down, 82A, New Bond-street, London, W.	618	0	0
Corlett Electrical Engineering Company, Wigan	615	0	0
Spagnoletti and Crooke, Goldhawk Works, Goldhawk-road, London	677	0	0
W. O. Rooper, Emery Works, Stafford	663	15	1
Benham and Sons, Wigmore-street, London, W.	836	0	0
Hall, Geary, and Co., Church Gresley, Burton-on-Trent	796	10	9

Wakefield.—At Tuesday's meeting of the Corporation the report submitted by Mr. Robert Hammond on the electric lighting tenders was considered. An interesting feature to be noticed was that the tenders of Messrs. Ferranti and Messrs. John Fowler for the engine-house plant were almost identical, being within £11 of each other, the amounts being £9,102 and £9,091 respectively. Mr. Hammond reported that either firm could be absolutely relied upon to turn out a first-class electrical job, and he left it to the committee to choose between the McLaren (horizontal) engines offered by Messrs. Ferranti and the Fowler engines

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included in Messrs. Fowler's tender. After a sitting of three hours, during which the *pros* and *cons.* were thoroughly discussed, the committee eventually decided to give out the whole of the works plant to one contractor, and the following tenders were accepted :

Boiler-house plant, engine-house plant, switchboard, and instruments, Messrs. John Fowler and Co. (Leeds) Limited	£10,900	0	0
Cables, culverts, and trenching, British Insulated Wire Company, Limited	3,192	3	4
Transformers and distributing switchboard, Messrs. John Fowler and Co. (Leeds) Limited	448	0	0
Arc lamps and posts, Brush Electrical Engineering Company	252	10	0
Meters, Westinghouse Electric Company, Limited	233	18	3
Overhead crane, Mr. Thomas Smith, Rodley, Leeds,	253	0	0

Total, £15,279. 11s. 7d., as against £15,893, the amount of Mr. Hammond's estimate submitted to the Local Government Board. Messrs. Siemens Bros. and Co.'s tender for the whole of the job was within £7 of the latter figure—viz., £15,900. The very successful working of Messrs. Fowler's plant at the Leeds Electricity Works largely contributed to their selection for the most important portion of the plant.

Southmolton (Devon).—The following were the tenders for wiring the factory buildings for the electric light and ironing, including all the electric generating plant, for the Southmolton Shirt and Collar Manufacturing Company, Limited :

Newton and Hawkins, Taunton (accepted)	£282	0	0
Pettit and Hands, London	406	0	0
H. F. Joel and Co., London	394	0	0
Walsall Electrical Company, Walsall	412	4	0
G. Hill, Manchester	715	0	0
J. Glover and Co., London	457	13	0
Macdonald and Collidge, Gloucester	429	0	0
F. W. Ball, Bristol	550	0	0
Paterson and Cooper, London	515	0	0
Brush Electrical Engineering Company, London	565	10	0
Acme Immisch Electrical Works, London	415	0	0
J. C. Howell, Llanelly	558	0	0
W. L. Paterson, Newcastle-on-Tyne	352	0	0
Mavor and Coulson, Glasgow (without accumulators)	198	0	0
H. T. Sully, Bristol	322	0	0
W. Mackie, London	470	0	0
Drake and Gorham, London	605	0	0
J. A. Edmondson, London	281	13	0
S. J. Waring, London	203	10	0
D. McClure, Stockport	340	0	0

Bedford.—The following were the tenders for the supply and delivery of 200 cast-iron lamp columns, carriers, and globes, for the Electric Lighting Committee :

Cast-iron tops.			
W. Bradley, Brighouse (accepted)	£449	0	0
Holham and Co., London	540	0	0
Phœnix Foundry Company, Derby	579	0	0
Alloa Iron Company, Alloa	620	0	0
Ulverston Shutter and Lift Company, Ulverston	625	0	0
Sharpe and Co., Lancaster	632	0	0
Newton, Chambers, and Co., Sheffield	650	0	0
Kilpin and Billson, Bedford	653	0	0
Pontifex and Co., London	700	0	0
Macfarlane and Co., Glasgow	811	13	4
Goddard, Massey, and Warner, Nottingham	850	0	0
Hart, Son, Peard, and Co., Birmingham	960	0	0
G. Smith and Co., Glasgow	1,050	0	0
Sheet copper tops.			
W. Bradley (accepted)	519	0	0
Hollam and Co.	660	0	0
Alloa Iron Company	715	0	0
Cochrane and Co., Dudley	650	0	0
Sharpe and Co.	782	0	0
Newton, Chambers, and Co.	800	0	0
Kilpin and Billson	765	0	0
Pontifex and Co.	950	0	0
Macfarlane and Co.	830	0	0
Lloyd's Works, Abercarn	563	6	8
Ashmore, Benson, Pease, and Co., Stockton	739	0	0
Goddard, Massey, and Warner	910	0	0
G. Smith and Co.	1,050	0	0
Mackenzie Bros., Edinburgh	1,350	0	0

Ayr.—Mr. E. G. Pink, the engineer, has reported to the Sub-Works Committee of the Town Council on the electric lighting of the town properties : "Specifications were sent to the four lowest tenderers for wiring the Municipal Buildings (see *Electrical Engineer* of September 13, p. 303), only three of whom submitted tenders. These are as follow : .

	Scottish Elec. Eng. Co. £ s. d.	M'Leod and Co. £ s. d.	W. G. Higgs and Co. £ s. d.
Wiring to points with fitting as per schedule	2 2 6	—	1 0 10
8, 16, or 32 c.p. lamps	—	0 18 6	—
Extra lamps	2 2 6	0 15 0	0 16 0
Ditto on new premises	2 2 6	0 18 6	0 16 0
Wiring only	—	—	0 12 9
Arc lamps	8 10 0	8 5 0	7 0 0

As none of the firms have submitted prices or designs of fittings, I recommend the acceptance of the lowest and only tender for wiring only—viz., that of Messrs. W. G. Higgs and Co., who are already carrying out the wiring of the Municipal Buildings most satisfactorily. Fittings to be selected. With reference to the arc lamps no details are given, and I recommend the acceptance of Messrs Higgs for the wiring only at £2. 4s. 6d. each. The arc lamps for the streets will be tested at Leeds on the 8th inst., and I should prefer to see them burning before adopting another type. It would be advisable to advertise for quotations for arc lamps suitable for our system, as there are many new designs in the market." On the motion of the chairman, the sub-committee have unanimously adopted the recommendations contained in the report. A minute of the Lighting and Hall Letting Committee states that "Mr. Higgs submitted a number of designs of electroliers for the Town Hall, and on the motion of Dean of Guild Girvin, seconded by Bailie Burns, the meeting unanimously adopted design No. 1, the diameter of which is to be 4ft. Mr. Higgs agreed to give a deduction of £27 from his original offer. The meeting agreed to adopt a fitting for the Council-hall and committee-room on the lines of design No. 1, a sketch and sample of which is to be submitted by Mr. Higgs for the approval of the chairman, town surveyor, and electrical engineer. Subject to approval of said design, the committee authorised the contract to be closed with Messrs. Higgs.

BUSINESS NOTES.

Morley.—The clock in the tower of the new Town Hall will be lighted by electricity.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,248.

Battersea.—The Vestry have decided to take the necessary steps to acquire power to light portions of the parish by electricity.

Gesellschaft fur Elektrische Unternehmungen, Berlin.—This Company proposes to issue new shares to the value of 15,000,000 marks.

Swadlincote (Derbyshire).—The Urban District Council have announced that the question of lighting Stanton by electricity is being considered.

Aberdeen.—The installation of the electric light which it is proposed to fit up in the public library will consist of 150 16-c.p. lamps, and cost £140.

Salt Lake and Ogden Gas and Electric Light Company, Limited.—Letters of allotment for the preference shares of this Company have been posted.

Southsea and Portsmouth Pyramidical Railway, Limited.—This Company, formed to work the Pyramidical Railway license for Southsea and Portsmouth, has been registered.

Partick (Lanark).—The Committee on Electric Lighting have recommended the Burgh Commissioners to await the result of the installation at Ayr before proceeding further with the matter.

Inverness.—The Town Council have unanimously resolved to oppose three applications which have been made to the Board of Trade by public companies to introduce the electric light into the town.

Swansea.—Mr. Leeder's motion for the recision of the decision to light the town by electricity was ruled out of order at Wednesday's meeting of the Town Council, as the question had been twice settled this year.

Hampton Wick.—The chairman of the District Council has mentioned that the Lighting Committee had not met yet, but would do so this month to consider the letters about electric light and other matters.

Appointment.—The Cork Corporation have appointed Mr. J. W. Smith to advise them on the electric lighting question. Mr. Smith may be recognised as engineer to Messrs. Calvert and Co., of Manchester.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 13th inst. amounted to £1,118, as compared with £906 in the corresponding week of last year, being an increase of £212.

Belfast.—The Electric Committee, under the chairmanship of Alderman Sir Daniel Dixon, D.L., have met and transacted routine business. We understand that further applications for the supply of electric light are continually coming in.

Bank-Lighting.—The electric lighting of the new Salvation Army bank has recently been carried out by Mr. Fredc. H. Taylor, A.I.E.E., of 17, Ironmonger-lane, E.C. The installation includes a 2,000-c p. arc lamp in the centre of the main hall.

St. James's and Pall Mall Electric Light Company.—The sale of electricity for the quarter ending September 29, 1895, representing the supply at 6d per unit, amounted to £7,402, as against £6,935 at the same rate for the corresponding period of 1894.

Manchester.—The Corporation have adopted a report of committee recommending the taking over of the tramways. An amendment to refer back to the committee to first ascertain whether it was desirable to substitute electrical for horse traction was lost.

Chelsea.—The Guardians have referred to the Finance Committee a letter from the Chelsea Electricity Supply Company suggesting that the new buildings should be wired, so that in the event of the Guardians deciding to use electric light there would be no difficulty.

Road and Rail Locomotive Company, Limited.—This Company has been registered with a capital of £1,000 in £10 shares. Object : to enter into an agreement for the acquisition of certain

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inventions in relation to tram, road, and rail locomotives, etc., and to develop and turn to account the same. Registered office: 47, Chancery-lane, W.C.

West India and Panama Telegraph Company.—The directors of the West India and Panama Telegraph Company, Limited, have decided to recommend for the six months ended June 30 a dividend of 6s. on the first and second preference, and of 1s. 3d per share on the ordinary share.

City and South London Railway.—The returns for the week ended October 13 were £916, compared with £920 for the corresponding period of 1894, being a decrease of £4. The total receipts for the half-year 1895 are £12,774, compared with £12,931 for the corresponding period of 1894, being a decrease of £157.

The Proposed Electric Railway in Derbyshire.—The provisional committee appointed at a meeting held in Derby some time ago to consider a project for the construction of an electric railway between Derby and Ashbourne have called two other meetings. One is to be held at Derby to-day (Friday), and the other at Ashbourne to-morrow.

Llanelly.—With regard to the letter of Mr. J. C. Howell, asking upon what terms the Borough Council were prepared to part with their provisional order, the Estate Committee have considered the matter, and asked for powers to treat with Mr. Howell in the matter. Ultimately, it was decided that a committee of the whole Board should meet Mr. Howell.

Chester.—Lord Kelvin has sent in to the Town Council his account for £105, which was the agreed amount for his report on the electric lighting of the city. The amount had not been included in the other accounts that had come up for payment, and the Mayor therefore proposed that it should be added to the other bills for payment. This was carried.

Astrachan.—The "Adelsklub" has resolved to electrically light the new clubhouse. The plant, consisting of two horizontal single cylinder petroleum-engines (Kaselovsky patent), one shunt dynamo, and a battery of accumulators (Pollak system), is to be supplied by the Berliner Maschinenbau Aktiengesellschaft vormals L. Schwartzkopff, Berlin, through its agent in Astrachan, Herr Supuck.

Harrogate.—The Town Council have adopted the report of the electrical engineer upon the tenders for electrical works, and recommend that tenders be let for £13,302. The estimates amounted altogether to £27,000. The Council have also decided to apply for powers to borrow a further sum of £2,000 for electric lighting, making the total £27,000 to be borrowed instead of £25,000, as originally fixed.

Plymouth.—The Town Council on Monday discussed Dr. Fleming's report on the electric lighting of the town which appears elsewhere in our columns. Ultimately, a recommendation of the Works Committee was adopted, that the Council should depute the Electric Lighting Sub-Committee to visit some of the large and successful electric stations in London and the provinces before taking any further action.

Headland's Patent Electric Storage Battery Company, Limited.—This Company has been registered with a capital of £15,000 in £1 shares. Object: to acquire the business of electricians and electrical engineers as now carried on by H. and E Headland, at Leyton, Essex, and to develop and extend the same. Manager, H. W. Headland; remuneration, £4 per week Registered office: 12, Pall mall, S.W.

Telegraphic Interruption in Australia.—As a link in the communication with Australia and New Zealand, it would seem that the Western Australian land lines (which carry the traffic of the alternative cable laid to Rcebuck Bay) are not to be relied on. From last month's Australian Press we learn that this line was faulty, and that "business was much delayed," occasional batches of five or six messages only being received

Cheltenham.—Alderman Norman, in introducing the minutes of the Electric Light Committee, spoke of the proposed conference with the gas company and of the progress of the electric light. Mr. Margrett congratulated the committee on the proposal to extend their lighting scheme as far up the High street as the Belle Vue Hotel, while Mr. Feeney hoped that the lighting of Regent-street would be improved. The minutes were confirmed.

Southend.—Councillor Bowmaker has been appointed chairman of the Electric Light Committee of the Town Council. The committee requested the advice of an engineer, and suggested Mr. A. B. W. Kennedy, of 14, Old Queen-street, Westminster. The terms would be 100 guineas for the report; if the work were carried out, 5 per cent. on the capital outlay, with out of-pocket expenses. The report and recommendation were carried.

Hornsey.—The Lighting Committee of the Hornsey District Council having considered a report of the engineer on the experiments which had been carried out under the direction of the committee with regard to incandescent lighting as applied to gas lamps, have recommended that the experiments should be discontinued, and that the engineer should keep the committee informed of improvements which may be made in modes of lighting public streets.

Halstead (Essex).—The question of electricity *v.* gas has been reported on by the Lighting Committee of the Urban Council. They had heard from several towns, and they found both at Sudbury and Braintree a considerable difference made between public and private lighting. They had had reports from two engineers, and the question of electricity was still under consideration of the committee. It was resolved to appeal again to the gas company.

Copper.—In the first fortnight of this month the deliveries of copper amounted to 5,989 tons and the supplies to 5,909 tons; so that the visible stock of 52,763 tons is only 80 tons less than on September 30 and 203 tons smaller than it was a month ago. Thus the statistical position has had nothing to do with the moderate decline in the price of G.M.B's. The arrivals from America were small, but there has been a considerable increase in the Chili charters.

Madras.—The second section of the Madras electric tramway from Egmore to Triplicane, is being pushed on rapidly, and has reached Barber's Bridge. The section is expected to be ready for traffic by the end of the month, and as it will be worked on the overhead system, the posts to carry the conducting wire are already being erected. These posts are of drawn steel tubing, and will be 17ft above the road surface, so as to cause no obstruction to vehicles of any kind.

Brazilian Submarine Telegraph Company, Limited.—The accounts of this Company show a profit sufficient to enable the directors to recommend a final dividend of 3s. per share, making, with previous distributions, a total dividend of 6 per cent. for the year ending June 30, and also a bonus of 2s. per share, both free of income tax, which together will amount to £32,500, leaving a balance of £34,410, of which sum £30,000 has been placed to the reserve fund and £4,410 carried forward.

Yarmouth.—The surveyor has reported to the Town Council that 135 more lamps had been applied for, making a total of 5,495. The expenditure during September was £133. 4s. 10d., and the income £222. 0s. 6d. The profits for August and September amounted to £142. 4s. 7d., which just covers the loss on the first seven months' work. The profit to be earned during the rest of the year he estimated at nearly £300, making the cost of the electric lighting works to the ratepayers about £550 for the first year's work.

Whitehaven.—The engineer to the Town Council has read correspondence with Mr. C. M. Mayson, of Cockermouth, who was desirous of entering the electric lighting station as improver for 12 months, for which he was willing to pay a premium of £50, and it was resolved that the offer be accepted. The plans submitted by the engineer for alterations at the electric lighting station were considered, and his plan and estimate of the cost of carrying the cables outside the engine house, along the street in front and up the yard on the north-west and an estimate of the cost of ventilating the engine-house, were approved.

Isle of Man Tramways Company.—The Douglas Town Commissioners have confirmed a draft agreement of the lease of the Douglas Bay Tramways for 21 years from December, 1897, to the Isle of Man Tramways Company. The agreement also authorises the Company to construct and work a cable tramway to Upper Douglas, the Company in consideration to pay the Commissioners 15 per cent. on the gross takings of the Bay Tramway from January 1 last, with a minimum payment of £15,000 per annum, and as from January, 1902 5 per cent. on the receipts of the cable tramway. The Company agree to maintain Sunday service cars.

Brazil.—It is stated that Cataguazes is to be lighted by electricity; also the quarantine station at Ilha Grande On board the steamer "Merchant" there arrived at Pernambuco recently the electric light plant for the city of Maceió. The cost of the electric light plant for Pará is estimated at 3,200,000$000. The city will be illuminated with 1,800 incandescent lights of from 16 c.p. to 25 c.p., and 86 arc lights of 2,000 c.p. The power will be furnished by eight steam-engines, and will be sufficient not only for lighting the streets, but also for 10,000 private lights of 16 c.p. The plant will be furnished by the firm of Siemens and Halske, of Berlin.

West Australian Electrical Trunk Power and Lighting Company, Limited.—This Company has been registered with a capital of £510,000 in £1 shares (10,000 deferred). Object: to carry on in West Australia and elsewhere the business of an electric supply company in all its branches; as electricians, electrical and mechanical engineers, suppliers of electricity, etc.; as manufacturers of and dealers in wires, cables, primary, secondary, and other batteries, accumulators, lamps, and apparatus; also to carry on business as a gas and water supply company, and, further, the business of a mining, milling, and smelting company in all its branches.

Messrs. Baxendale and Co., of Miller-street Works, Manchester (a suggestive application of one of whose "Ship Canal" searchlights is described in another column), are, we understand, extremely busy with installation work, having in hand, amongst other contracts, the lighting of the Manchester and Salford Ship Canal Docks and sheds on the alternating high-tension system; Horrockses, Crewdson, and Co., Preston, incandescent lighting, complete plant; J. and N. Phillips, Manchester; H. Samuel, Manchester, Brockie-Pell arc lamps and Livonia flashing signs; the Oldham Town Hall; the Turkish Baths, Oldham; Hill and Sons' mills, Dublin; and Hope Bros., Manchester, etc.

Bradford.—A correspondent writes to a local paper: "I should like to ask if our borough electrical engineer or any of the Gas and Electricity Committee can give a satisfactory reason for altering the town supply from 115 volts to 220 There has already been spent about £50,000, if not more, on this luxury, and, now they have got a good supply, they must start spending more money, and also cause their consumers to do likewise. There were in the town, up to December last, about 37,000 incandescent lamps running at 115 volts. At whose expense are all these lamps going to be changed to 220 volts? I think it will be a great injustice if the ratepayer should have it to do just to suit a lot of men who love spending other people's money."

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Ammeter Tests.—Mr. R. E. Crompton has recently completed a thorough test of three ampere-meters made by Messrs. Chamberlain and Hookham, Limited, of Birmingham, and reports that they start to register at ·15 of an ampere, and at ·33 ampere are only 20 per cent. slow. From this point onwards the maximum error in any one of the meters is 3·8 per cent. He concludes his report by stating that both as regards accuracy and mechanical fitness for its work the meter shows striking advances on any he had yet examined, and believes that it will be at the same time both durable and constant. Messrs. Venner and Sillar, of 10 Delahay-street, have been appointed London agents for the makers.

Wakefield.—In moving the minutes of the Electric Lighting Committee of the Corporation, which were adopted, Councillor J. L. Lee (chairman) said that steady progress was being made with the work. The tenders had come in, and had been inspected by the engineer. The prices were within the estimate. The committee hoped before long to have everything in order pending the decision of the Local Government Board as to borrowing powers. He could only urge the necessity of pushing on with the work, as there were some large customers waiting for the new light, who might provide it for themselves if the greatest expedition was not used. He hoped the buildings would soon be erected, and the works carried out to a successful issue.

Bolton.—The question of supplying electricity to the new station has been left to the chairman and vice-chairman of the Lighting and Electricity Committee and the engineer for consideration. A memorial from the inhabitants of Back Mary-street, off Derby-street, for street lamps was referred to the Lighting Sub-Committee. The electrical engineer (Mr. Rider) reports that there are now 81 connected consumers of electricity in the borough, and applications from nine other premises, making the total number of lamps 7,830 of 8 c.p. each. The maximum safe load of the present plant is only 4,800 8-c.p. lamps, and on the 4th inst. 1,930 lamps were burning at one time. Good progress is reported with the new engine and alternator.

Cardiff.—The Lighting Committee of the Town Council have received a letter from the Local Government Board stating that a public enquiry would be held in reference to the Council's application for permission to borrow £12,885 for electric lighting. Another letter received from the Local Government Board conveys sanction for the Council to borrow £3,500 for purchasing an electric lighting station in Womanby-street, the property of Messrs Brain and Co. A communication was received from Mr. T. M Hayward, Cathedral-road, stating that, on the understanding that the Council were going to bring the electric light mains down the road, he had fitted his place with wires. It was decided that the desires of the inhabitants as to using the light should be ascertained.

Barrow.—The new telephone trunk line has now been completed between Barrow and Whitehaven. This opens up direct connection with all parts of England, Scotland, Ireland, and Wales. The work of putting down the new trunk line has been carried out under the personal supervision of Mr. Chambers, of Whitehaven, the district manager for Cumberland, Westmoreland, and the Furness district for the National Telephone Company. The line is open for the use of subscribers, and has already been taken considerable advantage of. The Barrow exchange will now become an important centre of telephonic operations, not only by reason of an increase in the number of local messages, but as being an intermediate place between the Lancaster and Whitehaven trunk lines.

Braintree.—The surveyor to the Urban Council has stated that he found that at Braintree and Sudbury there was a considerable difference made between the price of gas to the public authorities and private persons. The surveyor was directed to again apply for a reduction of the price of gas. The chairman read a letter from Mr. Paynter, a gentleman who has recently taken Blue Bridge, Halstead, saying that the writer understood the Council were contemplating substituting electric light for gas in the streets, and he would be glad to act as the electrical engineer, as he had occupied a similar post abroad for many years. The clerk was directed to reply to Mr. Paynter, thanking him for his communication, and stating that the Council had not arrived at any resolution on the matter.

Portsmouth.—Alderman Ellis, speaking on the Corporation Electric Light Committee's report, said that the committee had purchased a Parsons turbo-alternator and generator for £1,750, of which £1,250 had been paid. The people living near the station had complained of the noise, and the committee, therefore, wanted permission for Messrs. Parsons to take back the condenser for a further £100. There would then be a balance of £400. A new surface condenser, noiseless, and more economical of coal and water, was proposed. It would cost a little more than the balance. The proposal was agreed to. The committee asked to be authorised to cut off the supply of electricity to any premises after giving seven days' notice. Alderman Ellis said this was necessary after "the parody of justice" they recently had in the County Court. Agreed to.

Killarney.—There is to be a contest in connection with the annual election of Town Commissioners. Each year four commissioners retire by rotation at this period, and until the vacancies are filled a good deal of local excitement prevails. During late years the election is mainly fought on the public lighting question, which is an important financial matter for the ratepayers. This will be the issue this year also, as the electric light company will endeavour to obtain a majority on the Municipal Board, and the gas company will exert their best endeavours in the same direction. As the Commission has been constituted it would appear to be equally divided on the lighting question, but of the four men retiring two are gasmen and two are supporters of the electric light. The result of the election, therefore will affect the power of either light on the Commission.

Electric Cranes.—An experiment is being made in London by a firm of wood merchants in the use of electricity for working the crane with which they stack their timber. They have found that manual labour is too slow, and that the use of steam power adds greatly to the cost of fire insurance. With their electrical crane they can lift loads of 15cwt. a height of 60ft., and so far as the trial has gone the crane has worked very satisfactorily. By means of levers, four different motions can be imparted. The dynamo from which the crane is worked is used in the evenings for the lighting of the works and offices Messrs. Glover and Co., of Hatcham Sawmills, who have made the experiment, believe that the crane will effect a considerable saving. In order that the workmen may have no grievance at the introduction of the apparatus, one-half of the difference in the cost of stacking the wood is to be handed over to them.

Wilmslow (Cheshire).—Mr. Ross has introduced a proposal to light the village by electricity. He submitted to the Urban District Council a draft agreement and a communication from the managing director of the Edison-Swan Company, in which they made an offer to the Council in case they applied to the Board of Trade for a provisional order, and consented to transfer the same to nominees, and would also guarantee the cost of obtaining the order, provided that such cost did not exceed £300. He spoke of the advantages to be gained if the place were lighted by electricity, and moved a resolution to the effect that the Council should apply for a provisional order to the Board of Trade. Mr. Fletcher, although in favour of applying for a provisional order, suggested that a committee should be appointed to deal with the question. Ultimately this course was decided upon, but on the motion of Mr. Clare it was decided to defer the matter for 12 months.

Woking.—The surveyor to the Urban District Council has reported that he had attended a meeting of the ratepayers of the St. John's and Goldsworth Ward, held to consider the proposal of the Council to light the ward. Estimates as to the cost of lighting with oil or electric light were submitted—viz. a rate of 6d. in the pound for oil, and 11d. for the electric light. The meeting unanimously resolved that the district should be lighted by electricity. He had obtained a tender from Messrs. New and Mayne, who estimated that the cost of erecting the standards as marked on the Ordnance map, would be £260, and the supply of current would be £4. 4s. per lamp of 2,200 hours, the same as in the Station District. The capital expenditure would be met by equal half-yearly instalments spread over a period of seven years. This represented an annual payment of £44. 18s. 8d, plus £168 for current, giving a total of £212 18s. 8d to be raised annually. The assessable value of the district was £4,606.

Kingsteignton (Devon).—A correspondent writes to a local paper: "Now that the water-supply question is finally set at rest after so many years' controversy, another matter of little less import comes to the front to take its place—the lighting of the village. Last winter we dwelt in Cimmerian darkness, and might as well have been living in the midst of Dartmoor, or at the North Pole Now we have a "Parish Council" (whatever that may mean), and there are some half-dozen paraffin lamps lighted in the High-street. They generally smell, not to say stink, and with any wind either smoke or blow out Will someone suggest to the Parish Council that the much-abused stream that flows through this village is quite capable of turning a turbine wheel, and generating sufficient electricity to, at a small cost, efficiently light the whole place, the first outlay being the only expense. The particulars may easily be obtained from Chagford, which is already lighted by electricity."

Waterford.—The Street Committee of the Corporation recommended that the application of the National Telephone Company to carry out a scheme for providing telephonic communication throughout the city be granted on their providing a free wire to Tycor and indemnifying the Corporation against all risk. The Mayor said the application of the company was of a very general and indefinite character. He suggested that, while they gave a general consent to the undertaking, they should ask for much more definite information than they possessed at present. They should exercise a stricter control over companies to whom it was proposed to give such a monopoly as in this case. Of course, it was right that an undertaking for the general benefit should not be impeded, but still the Corporation had a number of matters which they should look after and rights to conserve. It was decided to refer the matter back to the committee with instructions to obtain further information as to the projected works.

Chichester.—Councillor Edney has drawn attention to an item of £31. 10s., the cost of obtaining advice in connection with the subject of electric lighting. He also mentioned that a copy of the report which the Council had printed at the time had never been forwarded to him. Councillor Butler gave it as his opinion that the £31. 10s. for electric lighting advice was simply money spent to satisfy Councillor Prior's ambition. Councillor Prior observed that when the advice was obtained it was with a view of relighting the newly-added district, as it was thought before gas lamps were provided it would be better to ascertain the cost of electricity. The advice certainly cost the Corporation £31. 10s., but the money was not thrown away, because immediately afterwards the gas company lowered their prices to a considerable extent, and the city was a great gainer thereby. The advice was always at the service of the Council. His motion at the time was not, he was sorry to say, accepted, but he hoped at some future time the Council would take it up.

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Stafford.—The ceremony of formally opening the Stafford Corporation electric lighting works was performed on Tuesday last by the Mayor (Mr. C. H. Wright) in the presence of a large number of people. The Mayor and the members of the Corporation assembled at the Guildhall and thence walked in procession to the works. On arriving at the works Mr. W. H. Peach, the chairman of the Electricity Committee, was presented with a silver key, with which he opened the entrance door and admitted the public. An address, in which he traced the history of the enterprise, was delivered by Mr. W. H. Peach. The Mayor then started the first engine, and the Mayoress, a silver key having been presented to her for the purpose, switched on the light. The second and third engines were started by Alderman Silvester and Mr. G. Wormal (ex-mayor). The engines having been stopped, the Mayor declared the station open. Various toasts were then proposed, and subsequently the chairman of the Estates and Works Committee, Mr. Smallman, switched on the arc lamps in Gaol-square. The engine room was tastefully decorated for the occasion, and a number of interesting exhibits had been arranged by the electrical engineer.

Bath —The chairman of the Markets Committee has announced the receipt of a letter from Mr. Alex McTavish, electric light engineer, asking to be allowed to light the markets, the power to be obtained by means of an independent gas-engine He (the chairman) said that a dynamo was to be erected in the technical schools, and arrangements had been made to bring the wires through the roof of the avenue, but they would not be able to get the lighting done from this source until after Christmas, as the room required in the basement would not be ready for use until then. It was decided to hear Mr. McTavish who was in attendance, and from his statement it appeared that a gas-engine and plant could be laid down at an initial cost of £250, and there would be a cost subsequently of 6d. an hour for gas while the engine was working The engine would require but little attention. The cost of carbons and other incidentals would be about £1 a month. After some discussion it was decided to ask Mr. McTavish to bring up a report. In reply to Mr. Tonkin, statistics were given as to the cost of lighting the markets by gas, and from a subsequent revision it appeared that this was £51 2s. 6d. for the year ended September 25 last. The Corporation's bill for the electric light during the past quarter amounts to £514.

Competition. — The Vestry of St. Mary, Battersea, offer premiums of £50, £30, and £15 for the three best schemes, reports, designs, and estimates for electrically lighting the parish of Battersea. The first selected scheme, design, etc., is to become the property of the Vestry, and if the Vestry engage the competitor to carry out his scheme the premium is to merge into and form part of the commission or remuneration to be paid him. The instructions may be obtained at the Municipal Buildings, Lavender-hill, S.W., upon payment of £3. 3s., which amount will be returned after receipt of a *bonâ fide* scheme, report, etc., in accordance with the terms of the instructions. The schemes, etc , will be submitted to an independent engineer of eminence, who will advise the Vestry in their choice. The schemes must be delivered to Mr. W. Marcus Wilkins, vestry clerk, Municipal Buildings, Lavender-hill, S.W., without motto or distinguishing mark of any kind, but accompanied by the author's name and address in a sealed envelope (unaddressed), before 12 noon on December 12, free of expense to the Vestry and at the risk of competitors, and no schemes or other documents will be received after that day and hour. Canvassing any member of the Vestry or any person employed to advise in connection with the undertaking will be a disqualification.

The National Telephone Company, Limited, against whom proceedings for allowing a nuisance on their works at Spitalfields had been taken by the sanitary authority of the parish, have appeared again at Worship-street Police Court by their representative. The prosecution relied on the evidence of two sanitary inspectors to show that an objectionable effluvium was traceable to the works of the Company, where it was found that a process of vulcanising was carried on. The defence established the fact that the sanitary inspectors lived in the same house, in the same street as the Company's works, and within two doors, that they had so lived for years, and made no complaint, that the street was adjacent to Spitalfields Market, that a large stable was in the immediate neighbourhood, that an ash-heap and a manure pit existed within 40 yards of the officers' dwelling, and that another stable and a margarine factory were contiguous to the works of the Company. Mr. Bushby (the magistrate) having gone over the evidence, found there was no preponderating evidence on either side. In addition, he found that it was some time since complaint of the nuisance was made, and he had not been able to learn that the premises had been similarly used since; in fact, that the use was discontinued That being so, he thought this was not a case in which he should interfere, and it would therefore be dismissed, defendants' costs being refused.

Brandon and Byshottles (Durham).—A lengthy report has been received from the Corlett Electrical Engineering Company by the Urban District Council as to the lighting of the district, showing that the cost would be cheaper than that of gas In connection with the question a letter was read from Mr. E. C. Martin, clerk to the Witton Gilbert Parish Council, calling attention to the monopoly held by the Durham Gas Company in regard to the supply of gas under the old Act of Parliament of the Durham Gas Company, which had recently been manifested by the Witton Gilbert Council, inasmuch as the gas company strenuously held to their sole right to supply gas lighting in this district, and at double the cost the Council could have had it locally. The result was they had had to resort to electric lighting, and the Council thought it their right and duty to explain what they thought was a very great hardship on the part of the directors. Mr. Potts said their first consideration was as to whether they were going to accept a scheme, and they must decide whether it had to be electricity or oil. Mr. Galbraith said it was not the best policy to go back to that antiquated form of lighting the district by oil. He had also spoken to colliery managers and several experienced people who had electric lighting under their control, and their experience would not warrant them in giving much encouragement in this direction, not, at least, in their conversation with him. It was eventually resolved that the district be lighted, and that a special meeting of the Council be held to definitely decide by what means the lighting shall be effected.

Neston and Parkgate (Cheshire).—Mr. Grenfell again brought before the Urban District Council the question of electric lighting. He had recently sojourned in a small village in the Pyrenees, something like Parkgate. There was not a rich man in the place—in fact, their medical officer of health would condemn most of the dwellings, yet every house in this village had the electric light. There was one main switch connected with every room where the light was used, and the whole of the lights "blazed out" at once, and were extinguished at the same moment, so that there was no possibility of anyone stealing the light. After the electric light was extinguished they had to use such other lights as they had. There was no meter or anything of that kind, simply a charge of 1d. per light per night, and the whole of the work was done by the parish commune. When he was there in 1894 the village was in darkness, as there was then no public lighting of any kind. He thought they might reasonably adopt something of the kind at Neston. The village referred to had water-power handy, but in Neston they had cheap fuel, whereas at the village coal was £5 per ton. The chairman said that the lighting of the lamps alone cost them 25s. per week. Mr. Grenfell said he had communicated with a consulting engineer in London, and had agreed to pay him £5 to visit the neighbourhood and go into the matter. The engineer wished for a very small committee, and he (Mr. Grenfell) suggested that the latter should consist of Mr. Churton and Mr. Jameson. It was arranged that these gentlemen should serve on the committee. Mr. Grenfell remarked that a number of the tradesmen would take the light if it could be supplied at a reasonable cost.

Romford.—Mr. Westgate has proposed that the Urban Council should take the necessary steps to obtain powers to use the electric light for the parish of Romford. Mr. Stone seconded the proposition. The Chairman said that at the last meeting he expressed the opinion that the Board of Trade would not grant the power, seeing that they did not intend to carry out the work immediately. He thought that Mr. Westgate moved his proposition in order to prevent any other company coming in. Mr. Westgate said that was not so. Mr. Smith said a proposition almost identical with that proposed by Mr. Westgate was brought forward in 1882 by the Local Board. The opinion then expressed was that the matter should not be taken in hand, and during the 13 years that had intervened nothing had been done in the matter. He thought the Board of Trade would not consent to such a "dog-in-the-manger" policy as that proposed by Mr. Westgate. He proposed, as an amendment, that the Council do not deem it expedient or desirable to take any steps requisite for the purpose of using the electric light for Romford. The amendment was not seconded. Mr. Stone did not think it advisable for them to incur any great expense, but he thought they ought to take steps in the matter, as the time would come when they would have the electric light in Romford. Mr. Westgate said that as the times were advancing they must advance. The idea that they would be asking for the provisional order for the sake of keeping others out was ridiculous. The Chairman said he had hoped Mr. Westgate would have given some reasons for his proposal, and also have gone into the question of the expense of getting the electric light and the cost of maintaining it. The proposition was lost, only the proposer and seconder voting for it.

Taunton —The Electric Committee of the Corporation have reported that an application had been received from Mr. H. G. Turner, of Pinkhurst, to lay on the electric light to his houses at Staplegrove. As the houses are in the electric lighting area, the committee recommended the Council to lay an electric lighting main along the public roads from Elm-grove to Pinkhurst in order to supply his residence and other property in Staplegrove, provided that he will pay 5 per cent. upon the outlay, but when the income from private lighting in that district reaches £50 a year the percentage is to cease. The Corporation are to be at liberty to use the main for public as well as private lighting. The committee reported that they had accepted Mr. S. Garford as an articled pupil for three years at a premium of £100; no salary to be paid him for the first year, £20 for the second year, and £40 for the third year. The committee presented the indenture of apprenticeship, and recommended that the common seal of the borough be affixed thereto. The committee have instructed the town clerk to write to the Board of Trade informing them of the works which have been done with respect to laying underground mains and removing the overhead wires, and asking them for a further extension of one year as regards the remainder. The committee have also requested the Finance Committee to take the necessary steps for raising a further sum of £3,000, this being the balance of the £5 000 sanctioned by the Local Government Board in December last. Alderman Standfast asked what would be the cost of the laying of the new main, and Councillor Potter explained that it would be about £150 or £200. He could not say the exact sum, because it depended upon the way they laid the mains, and also upon the arrangements made between Mr. Turner and the Water Committee. The application of Mr. Turner was

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then granted, and the remainder of the recommendations of the committee adopted.

Wimbledon.—A public meeting, convened by the Wimbledon Ratepayers' Association in opposition to the electric lighting scheme adopted by the Wimbledon District Council, has been held in the Drill Hall, Wimbledon. Mr. T. C. Summerhays presided. The following resolution was proposed and seconded: "That this representative meeting of ratepayers having heard the objections raised against the electric lighting scheme of Mr. Preece recently approved by the Wimbledon District Council is of opinion that the same be opposed at the Local Government Board enquiry." Mr. Preece, who prepared the scheme for the District Council, rose to address the meeting. Replying to Mr. Cooke, he said it was not necessary to provide a special renewal fund in addition to the repairing fund. The Council borrowed its capital for 25 years, and in paying that off year by year they were paying off the cost of the machinery; hence it was unnecessary to have a sinking fund in addition. Mr. Cooke's point as to the engineer's salary arose from misapprehension arising from the manner in which the accounts had been drawn up. But the accounts were drawn up according to the Board of Trade requirements, and he was not responsible for the method. The actual salary paid to the engineer would be not £100, but £250 per annum. Mr. Crickmay asked what provision was to be made for private lighting in those streets where a separate private lighting main was not going to be laid down Mr. Preece replied that the public lighting mains might be tapped without any detriment to the street lamps, because provision had been made in these mains for supplying in addition to the street lamps no less than 10,000 private lights. Mr. Preece attempted to proceed, but was interrupted by cries of "Vote!" and he was obliged to sit down without further replying to his critics. It was then about a quarter past 10 o'clock, and the Chairman, without further delay, put the resolution to the meeting, and declared it carried almost unanimously.

Birmingham.—With reference to the brief account of the electrical installation at the new technical school in Suffolk-street which we gave in our last issue (p. 427), we should state that the generating plant consists of three Tangye gas-engines, each capable of developing continuously at least 53 b.h.p. when running at 160 revolutions per minute. Each engine has two heavy flywheels, 7ft. in diameter and 10in. wide. The three engines, together with three compound-wound dynamos, by Thomas Parker, Limited, of Wolverhampton, are placed in a room in the sub-basement. The dynamos run at 900 revolutions per minute, and are driven by leather belts running on to compound iron and leather dynamo pulleys, designed to prevent slipping while running with slack belts. Very massive fly-wheels are applied to these dynamos, each 4ft. in diameter, and having solid rims 8in. by 8in, including weldless steel hoops shrunk over. Gas is brought into the building from the street mains through a cast-iron pipe 7in. in diameter. Instead of the cylindrical cooling vessels usually supplied with gas-engines a large cast-iron tank 24ft by 3ft. deep, holding 6,000 gallons of water, is placed above the battery-room, of which it forms the roof A gallery erected above the dynamos carries the switchboard. Special connections are employed for enabling the three dynamos to be run in parallel. At one end of the gallery is a combined motor and dynamo, which takes a part of the current from the main dynamos and charges 58 storage battery cells, which were made by the Electrical Power Storage Company, Limited, of London, each cell containing 34 plates, and being of the central-station type. These cells are for lighting the corridors, staircases, and such rooms as may require artificial light when the machinery is not running. They are only capable of supplying a small proportion of the total number of lamps installed. As soon as the demand reaches about 100 amperes one of the main engines is started, and another and a third if required With regard to the lighting of the building, there is considerable variety—a circumstance which greatly adds to the educational value of the installation. In various rooms use is made of 16-c.p. incandescent lamps, 50-c.p. incandescent lamps, Crompton arc lamps of the ordinary pattern, and inverted arc lamps. The last have large reflectors underneath, which throw the light upon whitened ceilings, the illumination being thus indirect, and a beautifully soft light is obtained, with an effect resembling ordinary daylight. In the mechanical drawing office this kind of light is much appreciated, and in many of the workshops, where the shadows cast by the ordinary lights are objectionable. Electricity is used in the school for motive power purposes. Thus there are 15 electric motors in the building of a total of 46 h.p. In the electric engineering room there will be an admirable set of machines specially arranged by Dr. Sumpner (the principal). Here the electrical connections have been so designed that each machine can be used either as a dynamo or as a motor. Continuous and alternating currents will be produced by these machines for experimental purposes. A separate set of storage batteries and a specially arranged switchboard help to render this room very complete for its intended purpose. No one can see the electric motors without being struck by the convenience of the system of distributing power by electricity. It would have been quite impracticable to have conveyed the power throughout this building by means of lines of shafting and belts. The motors are started instantly and stopped as quickly, and require hardly more attention than a common blowing-fan.

Reigate.—A special meeting of the Council of the borough of Reigate has been held in the Market Hall, Redhill, for the purpose of considering the question of electric lighting for the borough. The town clerk read a letter from Messrs Charles J Grist and Co., of 20, Gracechurch-street, London, E.C., dated May 21, which was presented to the Council at the time, stating that they had been approached by several of the inhabitants of Reigate with reference to the electric light, and that they were thinking of applying to the Board of Trade for a provisional order to supply the current, and would propose laying mains in the following roads: London-road (Yew Tree end), London-road (Bell street end), Somers'-road, Castle-road, High-street, Wray Park-road Birkheads-road, Raglan-road, Alders-road, Alma-road. Church-road, Doods-hill or Croydon-road, Reigate-road, Bell-street. Of course, they added, the matter was only in embryo, but they were writing to ask the Council to give their consent before they (Messrs. Grist and Co.) gave notice of their intention to apply for a provisional order within a certain specified time Further correspondence presented included a notice from the Guildford Electricity Supply Company; letters, with enclosures, from the Town and Village Electric Light and Power Company, Limited; a letter from Mr. F. J. Warden-Stevens to the Mayor; and a circular letter from the Incandescent Light Company, Limited. The next item on the agenda was—"Matter to be brought forward by the Mayor 'To consider the expediency of applying to the Board of Trade pursuant to the Electric Lighting Acts, 1882 and 1888, for a license or provisional order authorising the Urban District Council for the borough to supply electricity within the area of the said borough, for public or private purposes, or for both such purposes.'" His worship explained that, as the Council were all aware, this meeting had been called in consequence of a resolution that was passed some months since by the Council requesting him to convene a meeting. He would ask some member of the Council to propose any motion that he wished to submit. Councillor Powell moved, "That the Council appoint a sub-committee to enquire into the matter of supplying electric lighting in the borough, and report on the same to the Council; and that the sub-committee be empowered to employ a professional electrical engineer to advise as to cost, etc." He need not, he said, adduce very many arguments in favour of the electric light. There was no doubt that up to the present time it was the best light that had been invented. The motion was carried after a long debate. Upon the proposition of Councillor Gilbert it was then resolved by 15 votes against 3 that the town clerk obtain counsel's advice as to the legality of gas shareholders voting upon the question. Alderman Pym and Yerworth and Councillors Barnes, Powell, Viall, Meier, Holman, Giles Gillham, Apted, Sanders, and Richardson were appointed the sub-committee, the Mayor stating it would have to be reconstituted on November 9.

Dover.—The Managing Committee of the Town Council have discussed the question of the construction of an electric tram in Dover. Councillor G. Fry moved that the town clerk be requested to obtain parliamentary powers to construct a tramway in the borough, and to work the same by other than horse power. He said that he thought the time had now arrived when they could safely construct a tramway from the pier to Buckland with a branch to Maxton through Priory-street or Worthington's-lane. They could not have done it before, and it was only due to the widening of Cannon-street and Biggin-street that they were able to effect it. During the last six or eight months the question of traction had very much developed, and he had just got a report from his managers in London and Ireland, who had been on the Continent, and had visited France, Holland, Germany, and Belgium, to report on the mode of traction in the various tramways in those countries, from which it seemed that the system of traction that was the easiest and the least expensive was by electricity. He did not propose to utilise the works in Maison Dieu-road to obtain the power, but if this was carried—and he was only shadowing forth at present his proposition, so that the Council could be perfectly *au fait* with the subject—he should propose that they should create the power on either of the vacant spaces at the top of Worthington's lane or at the rear of the Red Cow. He then proceeded to read an extract from a report pointing out the ease with which the tram was steered and that it could be promptly brought up. It ascended heavy gradients with facility. The tram could be turned with ease on a turntable, and there was no noise or smoke He offered to show any member of the Council the tramway at work at 32, Queen Victoria-street, on a miniature scale, and they could there easily understand and see how simple it was. The Mayor could tell them that the grand harbour of refuge was a practical fact and settled to be done, and that there were now some 20 gentlemen at work making a detailed survey, and within a very short period estimates would be obtained and the work would be in hand. Some hundreds of thousands of pounds would be voted in order that the work could be proceeded with with the greatest despatch and be completed within 10 years, and when completed they would have one of the finest harbours of refuge on the coast, and costing many millions of money. As a matter of course it would necessitate the employment of a very large number of workmen. If they did not take this matter in hand, someone else would. The cost of the power for running a car from the pier to Buckland was at the rate of 1¼d. per mile, and would therefore be 2½d., and they would carry 36 passengers. He would not ask them to pass a resolution that day, but he hoped they would consider it and authorise Mr. Knocker to obtain the parliamentary powers, which would cost from £300 to £500, the latter about the maximum. The Town Clerk remarked that he thought only a provisional order would be required, as he believed the power would only be granted from time to time. Councillor Fry said he thought a small committee should be formed to go into details, and enable the Council to come to a conclusion whether it was a right and proper thing in the interests of the ratepayers and working classes that they should construct this tramway. He thought they might

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take it from him that it would cost about £8,000 per mile. The cost of the construction of the buildings, land, and machines would be about £10,000, and practically there would be a total outlay of from £36,000 to £40,000; but even supposing it cost £50,000, in borrowing the money at 3 per cent. and spreading the repayments over a number of years, and looking at the small cost of working, and that almost everyone would ride in the trams, he thought that there would not be any fear that they would not pay. He had been connected with trams for the last 30 years, and was chairman of one of the principal companies in London, and vice chairman of the Irish company and another in the south of London, and he had some experience, and knew that he was advising them for the good of the town and the benefit of the working classes. It was eventually ordered that Councillor Fry's notice of motion should be placed on the agenda on November 9.

Monmouth.—The Town Council have received the following letter from the Local Government Board: "Sir,—I am directed by the Local Government Board to state that they have had under their consideration the report made by their inspector Colonel Ducat, after the enquiry held by him with reference to the application of the Town Council of Monmouth for sanction to borrow £20 000 for purposes of sewage and electric lighting. Having regard to the local objections that have been made to the scheme so far as it relates to electric lighting, the Board, before further considering the application, desire to be furnished with a careful estimate of the annual outlay and receipts on that scheme alone. For this purpose it should be assumed, for the time being, that the entire capital outlay in connection with the mill is required for the electric lighting scheme, and the annual charge for the repayment of, and payment of interest on, the loan for this purpose should be debited to the electric lighting account. The Board request that the item which will be put forward as representing the income from the sale of electric light may be supported by more definite evidence than has yet been given of the number of lights which will be taken by consumers, and of the payments which will be received for them. Any actual promises to take lights in the event of the scheme being carried through should be separated from the cases where the figures are based only on an estimate. As regards the sewerage and sewage-disposal scheme, I am to enquire what would be the detailed estimate of its cost in each of the following cases: (*a*) if the electric lighting scheme were omitted altogether, but the use of the proposed water power were continued, solely in connection with the sewerage scheme and the repayments of the loan charged solely to that account; (*b*) if no water power were used, and the force for pumping the sewage were derived solely from engines.—ALFRED D. ADRIAN, assistant secretary." The annexed extracts are from the Council's reply: "My Council have to say that the estimate of the first cost of the electric lighting scheme suitable for supplying 2,500 lamps, each of 8 c.p., or their equivalent, installed is the sum of £5,600. The revenue to be derived is as follows: Amount at present expended annually for gas in street-lighting, which will go to the credit of electric lighting when the gas is replaced by electricity, £329. In addition to this there is an equivalent of 160 8-c.p. lamps which are under corporate control, which it is estimated will earn £56. Amount of revenue under corporate control, £385. The above lighting will absorb the equivalent of, say, 600 8 c.p. lamps, leaving therefore 1,900 to be distributed among private customers When the whole of these 1,900 lamps are taken up, the revenue to to be obtained from them may be estimated at 6s. 8d. per 8-c.p. lamp per annum, or £633. 6s. 8d. This, when added to the above £385, makes a total revenue to be derived from electric lighting of £1,018. 6s. 8d. Further, in the foregoing statement no credit is taken for three items of revenue which will be earned by the electric light installation if both schemes are carried out jointly: (1) the pumping of the water for market purposes at present obtained from the company—this equals £50 per annum; (2) the cost of pumping the sewage—this is estimated to be at least £150 per annum; (3) promises to date for motive power—value, £25 per annum. If the sewage scheme is alone to be sanctioned, the Council would not propose to use the water at the Old Forge Mill at all. Its distance from the site of the proposed sewage station is so great that no economy at all, but an increase of expenditure would result from the use of this water power. The estimated cost of the sewage schemes alone is £12,000, and, allowing 5 per cent. for the payment of capital with interest on the same and adding the working expenses (estimated at £308 per annum), a total annual cost of £908 per annum is reached—equal to a rate of 12 pence in the one pound sterling. It must be remembered that the whole intention of establishing the electric lighting scheme in conjunction with the sewage scheme is to thereby lower the cost to the rates of establishing the sewage scheme alone, and in connection with this it must also be remembered that the electrical machinery can be employed during the hours of daylight to pump the sewage (this being the time when the sewage is produced), the same machinery being employed to earn revenue from electric lighting during the hours of darkness, when practically no sewage is produced.—T. R. OAKLEY, town clerk."

Leeds.—As we announced last week, the Leeds City Council passed a resolution authorising the sale of the electric lighting plant now in the Municipal Buildings, with the exception of one gas-engine The question subsequently came before the Corporate Buildings Sub-Committee, and, as it was thought that the modern installation of engines and dynamos might be utilised by other branches of the Corporation service, it was agreed to delay the matter for a month to give the various departments an opportunity of notifying their wishes. There are two sets of dynamos in the Municipal Buildings, the first of which is rather antiquated and worked by gas-engines, while the second is of the best modern construction and worked by steam. The Town Council held a special meeting on Tuesday last to consider the report of the Tramways Sub Committee upon the subject of tramway traction. Alderman Firth, the chairman of the Highways Committee, said the Council had to decide the kind of haulage which should be adopted in the future. He thought there would be no two opinions that there was no more inhumane kind of tramway traction than horse haulage; and the committee had come to the conclusion that horses should be abolished as far as Leeds was concerned. As to steam haulage, the committee considered that it ought not to be tolerated longer than reasonable Then came the question of motors worked by oil, but after carefully examining this system, which was only in an experimental stage, the committee felt that it would not do for Leeds to have an experimental scheme. Another kind of haulage suggested was that of motors worked by gas but this, too, the committee unanimously felt would not do, as it could not be claimed for it that it had been a success up to the present time. The only two systems left for them to consider, therefore, were the cable system and electricity. It must be patent to everybody who had given the smallest consideration to the question that both systems could not be adopted, as it was necessary to have through communication from one part of the city to another without any change of tramcars. The committee had no alternative but to choose between these two systems. In the case of the cable system, the initial cost would be £428,922, and the working cost would be £101,819. The initial cost of the electric system would be £378,499, and the annual working cost £90,072. These figures, compared with the estimates of the cable system, showed a saving of £50,423 in the initial cost, and of £11,747 in the annual working. In the opinion of the majority of the members of the committee the electric system beat the cable hollow. In the cable system three-fourths of the power generated had to be used to work the cable itself, even if there was not a single car upon it, whereas with electric traction practically all the power generated was usable. After enumerating other advantages of the electric system, Alderman Firth remarked that the residents in Roundhay-road complained very much about the electric poles and wires at the time of their erection, but now they scarcely found an inhabitant of that district who would consent to their demolition and to the abolition of the tramways. One difficulty could be surmounted by the power which was being sought in a parliamentary Bill to erect the electric poles on the face of the buildings The Tramways Committee were all but unanimous and the Highways Committee nearly unanimous, not entirely, on this question There was a very large majority in favour of the adoption of the electric system. He moved and Alderman Scupham seconded, the adoption of the committee's report. Mr. Hannam moved an amendment that the question be referred to the committee for further consideration He did not think that the citizens of Leeds contemplated that they should disfigure the city by introducing the system of overhead wires in connection with electricity. As to electric haulage, he believed that the self containing accumulator system would be very much improved in the near future and largely adopted. A twelvemonth to await developments might be a matter of great advantage. Mr. Leuty, M.P., said, although he supported the proposition, he did not wish the Council to commit itself to putting down all the miles of conduit system mentioned in the report The Council then debated the question for about five hours, the objections raised being not so much to the principle of electric traction as to the system to be adopted. Ultimately, on the understanding that the committee would experiment with a short length of the conduit system connected with the overhead system, the original motion was carried by 40 votes against 11.

PROVISIONAL PATENTS, 1895.

OCTOBER 1.

18318. **Improvements in hanger-boards for electric arc lamps.** Thomas Edgar Adams 18, Buckingham street, Strand, London. (Complete specification.)

OCTOBER 2.

18376. **Improvements in holders for incandescent electric lamps** William Matthew Hart and William Henry Whiteside 2 Market street, Bradford.

18385. **Duplex telephony** Abner Mulholland Rosebrugh, 107, Mutual street, Toronto, Canada.

18406. **Mode of producing contemporary hypochlorites, chlorates, hydrochloric acid, caustic soda, and hydrogen from the sea-water by means of the electricity.** Giovanni B. Baldo, 16 Via Stadion, Trieste, Austria (Complete specification.)

18420. **Improvements in electrical apparatus for railway signalling.** Alfred Horatio Sisson Daniell, 1, Queen Victoria-street, London.

OCTOBER 3.

18440. **Improvements in arc lamps.** George Hill, 17, St. Ann's-square, Manchester.

18453. **Electric cable casings.** George Hinde Nisbett, 8, Quality-court, Chancery-lane, London.

18483. **Improvements in electric glow lamps.** George Davis, 246, Vauxhall Bridge-road, London.

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18484. **Improvements in safety devices or fuses for electric circuits.** Arthur Marston Billington, 46, Lincoln's-inn-fields, London.

18505. **A new or improved method of and apparatus for electrically transmitting indications or changes of position of a body.** Harry Otto Ferdinand Bindemann, Norfolk House, Norfolk-street, London. (Complete specification.)

OCTOBER 4.

18531. **Improvements in recording instruments for telegraphic and other purposes.** William Thomson, Baron Kelvin, 154, St. Vincent-street, Glasgow.

18557. **Improvements in galvanic and storage batteries.** Joseph Baxeres Torres, 17, St. Anne's-court, Wardour-street, London.

18583. **Improvements in means for making electric connection between lengths of rail and the like.** Henry Edmunds, 47, Lincoln's-inn fields, London.

18584. **Improvements in or connected with electrical conductors.** Henry Edmunds, 47, Lincoln's inn fields, London.

18586. **An improvement in secondary batteries or accumulators.** Richard Pearson 53, Chancery lane, London.

18588. **Improvements in fusible cut-out or safety devices for electric conductors.** Gerald William Partridge and Arthur Francis Berry, 46, Lincoln's-inn-fields London.

OCTOBER 5.

18602. **Improvements in electric light and tail lamps for omnibuses, tramcars, and other road vehicles.** Henry William Headland, 77, Chancery-lane, London.

18622. **Improvements in commutator brushes.** Nathaniel Greening and N. Greening and Sons, Limited, 70, Market-street, Manchester.

18632. **Improvements in holders for incandescence electric lamps.** Charles Mark Dorman and Reginald Arthur Smith, Ordsal Station Electrical Works, Salford, Manchester. (Complete specification.)

18673. **An automatic speed regulator for electromotors** Louis Denayrouze, 28, Southampton-buildings Chancery-lane, London.

18681. **Improvements in alternate-current distribution.** Galileo Ferraris and Riccardo Arno, 45, Southampton-buildings, Chancery lane, London.

18692. **Improvements in the construction of electrodes or plates for secondary batteries.** Frederick Edward Everard 59, Roden-street, Holloway London.

18696, 18697, 18698, 18699, 18700, 18701. **Improvements in or connected with electric railways or electric transport.** James Grieve Lorrain, Norfolk House, Norfolk street, London. (Frederick Carleton Esmond, United States.)

OCTOBER 7.

18725. **Improvements in electric cables.** George Hinde Nisbett, 8, Quality-court Chancery-lane, London.

18726. **Improvements in electric cables.** Joseph Arthur Lovel Dearlove and George Hinde Nisbett, 8, Quality-court, Chancery-lane, London.

18769. **Improvements in or relating to the transmission of electricity and sound, and a means of reducing electrical resistance in the air, earth or sea.** Richard Joseph Crowley, Mitre-court, Fleet street, London.

OCTOBER 8.

18822. **Improvements in mounting electric incandescence lamps for orchestral reading and like purposes.** William Crawshaw and Henry Bevis, 73, St. Stephen's-road, Upton Park, London.

18868. **Improvements in electric velocipedes.** Hosea Waite Libbey, 45, Southampton-buildings, Chancery-lane, London.

18870. **Improvements relating to electromotors and transformers.** Walter Langdon-Davies and the Alternate-Current Electromotor Syndicate, Limited, 24, Southampton-buildings, Chancery-lane, London.

18875. **Improvements in concentric electric cables.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

OCTOBER 9.

18911. **Improvements in electrical hanging bell push.** Henry Benest, 15, Campbell-road, Bow, London.

18912. **Illuminated decoration by electric light in plaster ornaments.** Charles Gillard, High-street, Chard, Somerset.

18931. **Improvements in prepayment apparatus for attachment to gas, electricity, or other fluid meters.** Wesley Webber, 4, South-street, Finsbury, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 16, 1895, being date of application in United States.)

18935. **Improvements in apparatus employed in regulating electromotive force in alternating-current circuits for theatre-lighting or other useful purposes.** Isaac Probert and Ernest Francis Moy, 433, Strand, London.

18944. **An improved method of insulating electric conductors.** George Sutton and Robert James Hatton, 53, Chancery-lane, London.

OCTOBER 10.

19002. **An improved wheel trolley for single-wire system of electric traction.** Henry Brecknell, 64, Lawrence-hill, Bristol.

19027. **Improvements in electric metering apparatus.** William Lloyd Wise, 46, Lincoln's-inn-fields, London. (William S. Barstow, United States.)

19067. **Improvements in electric signalling apparatus.** Frank Warren, 40, Chancery-lane, London.

OCTOBER 11.

19104. **An improved method of making and applying electric rail-bonds.** Frank Edward Buxton, 5, John Dalton-street, Manchester. (Date applied for under Patents, etc, Act, 1883, Sec. 103, April 15, 1895, being date of application in United States.) (Complete specification.)

OCTOBER 12.

19177. **New or improved electric lantern for velocipedes.** H. Otto Johnsen, 7 Quality-court, Chancery-lane, London. (Complete specification.)

19199. **Improvements in dynamos.** Anthony George New and Arthur James Mayne 55, Chancery-lane, London.

19204. **Improvements relating to electric signalling in open circuits** Joseph Rayner Gibson, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1894.

10426 * **Dynamo-electric machines.** Kingdon. (Amended specification.)

18172. **Extracting gold by electrolysis.** Maclean and Bull.

18427. **Electrical traction.** Hutin and Leblanc.

19668. **Arc lamps** Gomess.

20595 **Railway electrical signalling devices.** Grimes.

21366. **Electrically-propelled vehicles.** King.

22340. **Multipolar dynamo machines.** Addenbrooke.

1895.

9937. **Secondary batteries.** Hammacher.

12622 **Secondary or accumulator cells.** Müller.

13573 **Telephone switches.** Stock.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¾-6¼
Brush Company, Ordinary	3	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	2-2¼
—— 4½ per cent. Debenture Stock	100	111-114
Charing Cross and Strand	5	5¼-5¾
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6¾-7¼
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	133-137
City and South London Railway, Consolidated Ordinary	100	38-40
—— 4 per cent. Debenture Stock	100	134-136
—— 5 per cent. Pref. Shares	10	14½-15½
County of London and Brush Provincial Co., Ordinary	10	8¼-9¼
—— 6 per cent. Cum. Pref.	6	8¾-9¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¼-2
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅞-1⅛
—— 6 per cent. Debentures	—	95-100
—— 7 per cent. Cumulative Pref.	2	2-2¼
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	1-1¼
Fowler-Waring Cables	5	¾-1
W. T. Henley's Telegraph Works, Ordinary	10	2-2¼
—— 7 per cent. Preference	10	14-14½
—— 4½ per cent. Debentures	100	16-16½
House-to-House Company, Ordinary	5	100-109
—— 7 per cent. Preference	5	4-4½
India Rubber and Gutta Percha Works	10	8-8½
—— 4½ per cent. Debentures	100	19-20
Kensington and Knightsbridge Ordinary	5	100-102
—— 6 per cent. Pref.	5	8-8¼
Liverpool Electric Supply, Ordinary	5	7-7¼
Liverpool Overhead Railway	10	7¾-8¼
—— 5 per cent. Pref.	10	11¾-11⅞
—— 4 per cent. Mortgage Debentures of £100	100	15-15½
London Electric Supply	5	112-114
Metropolitan Electric Supply	10	¾-1
—— 4½ per cent. First Mortgage Debenture Stock	100	11½-12
National Telephone, Ordinary	5	117-119
—— 6 per cent. Cum. First Pref.	10	6¼-6⅝
—— 6 per cent. Cum. Second Pref.	10	16-18
—— 5 per cent. Non. Cum. Third Pref.	5	15-16
—— 3½ per cent. Deb. Stock	100	6¼-6½
Notting Hill Company	10	106-108
Oriental and Electric Company, £1 shares	1	8¼-9¼
—— £5 Shares	5	1-1¼
—— £4½ shares	4½	7½-7¾
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	6-6½
Southampton Electric Company	—	104-106
St. James's and Pall Mall, Ordinary	5	—
—— 7 per cent. Pref.	5	8¼-8¾
Telegraph Construction and Maintenance	12	9-10
—— 5 per cent. Bonds	100	43-45
Waterloo and City Railway, Ordinary	4	104-107
Westminster Electric Supply, Ordinary	5	4¼-4¾
Yorkshire House-to-House	5	8¼-9
		6¼-7

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NOTES.

A Good Substitute for Guttapercha is said to be prepared as follows: Tar, one part; paraffin, 10 parts; dissolve together at 120deg., and then add caoutchouc, two parts. Keep at this temperature until a homogeneous mass results.

International Exhibition at Kiel.—From the end of May to the end of September, 1896, a naval and fisheries exhibition will be held in Kiel, in conjunction with an industrial exposition of the province of Schleswig-Holstein. It is proposed that electricity shall be well represented at the show. Particulars may be obtained from Herr Geh. Kommerzienrath Sartori, or Herr L. v. Bremen, in Kiel.

A Substitute for the Electric Bell.—What is called an electric trumpet, the invention of Captain Zigang, is described in *L'Etincelle Electrique* of October 20. It is proposed as an improvement on the ordinary electric bell. The mechanism closely resembles that of the latter, except that the hammer strikes on a thin metal plate mounted in a ring similarly to a telephone plate, and that the make and break is very much quicker. It is stated that the sound produced is musical, and the pitch can be altered by varying the pressure on the spring.

Conduction of Metallic Filings in a Dielectric. M. G. T. Lhuilier has been experimenting at the Prytanée Militaire on the conductivity of metallic filings contained in a dielectric. Copper, aluminium, and iron filings were tried with various dielectrics, both solid and liquid. The conclusion arrived at is that the dielectric in such cases never acts as a conductor. With dielectrics composed of organic substances, conductivity is established concurrently by the metallic particles in contact and by particles of carbon produced by the dissociation of the dielectric. With sulphur only the former occurs.

Cost of an Arc Lamp per Year.—Figures have been published in the States giving the "usual cost of operating and maintaining an arc lamp per annum." Four pounds of coal per hour for 12 hours would be required for every 2,000-c.p. lamp for 4,000 hours per year. In Albany this would cost 26·40dol. per year. Other items which are enumerated bring the cost of supplies to 58·40dol., to which are added labour, 29dol., and interest and depreciation, 43·33dol., making a total of 130·73dol. In 101 cities in the United States having all-night service the average annual charge is 150·72dol.

Trees and Lightning.—In a series of experiments made to ascertain why trees are so frequently struck by lightning, it was demonstrated that the green wood of pine trees is a bad conductor, and so much the worse in proportion as the tree is richer in oil. On the contrary, the green wood of such trees as are poor in oil conducts electricity relatively well. Living wood is a much better conductor than dead. The existence of dead branches in trees of both categories, therefore, increases the danger. Compare the note "Nature's Lightning Rods," in the *Electrical Engineer* of October 11, p. 409.

Calcium Carbide.—Herren Otto Mielke and Eduard Worringen discuss, in the *Elektrotechnischer Anzeiger* of October 20, the direct application of calcium carbide to electric lighting and incandescent lamps with calcium-carbide filaments. The light given by the latter is stated to be "surprisingly brilliant," and to be a colour between that of the arc lamp and the carbon-filament lamp; and the eyesight is not in the least affected by it. The calcium-carbide lamp, candle-power for candle-power, and voltage for voltage, is two-thirds of the size of the carbon lamp, and it is said to be equally adapted for indoor and outdoor illumination.

Electrically-Worked Turrets.—The President of the French Republic has recently visited the works of the Compagnie des Forges et Chantiers to inspect the Canet gun turrets ordered by the Danish Government. According to the *Semaine Electrique*, these present great facility in working. The loading and direction are done electrically, but the elevation is done by hand, as this is absolutely necessary for work at sea. There being no water under pressure, the danger of freezing is avoided. The tower is manipulated by a single handle, and if the operator is killed in action it continues its rotation to the point determined on, when the current is automatically cut off and the tower comes to rest.

The Addition of Lead to Copper.—The addition to copper of high conductivity of a small quantity of lead for increasing fluidity is the subject of a recent patent. It has been discovered that the addition of a certain proportion of pure lead, preferably from 0·5 to 1·5 per cent., detracts but very little from the conductivity of the metal, and, so far as experiments have been made, in a far less degree than the addition of either tin or zinc, which metals have hitherto generally been employed to improve the castings. It may be mentioned that this addition of lead has long been known to have this effect on gunmetal and brass. It has also been known that the addition of lead to molten cast iron has a similar effect and produces cleaner castings.

The Electrical Production of Metallic Mirrors forms the subject of a patent taken out by Herr Hans Boas, of Kiel. The method is based upon the by no means new observation that various metals—namely, those of high specific gravity, therefore particularly the precious metals—enclosed as electrodes in a Geissler tube or other vacuum vessel upon the passage of an electric discharge, for example, of a Ruhmkorff spark inductor or of a high-pressure direct or alternating current, in so far as they form the cathodes, are dissipated and deposited as metal or its oxygen combination on the walls of the vessel. If the tube or the holder be filled with an oxygen-free gas of low pressure, say, with hydrogen, the metal, it is stated, is compactly deposited in perfect purity on the vessel sides, and produces a mirror of a lustre such as is not to be obtained by any other method.

Norwegian Waterfalls.—The sale of cascades in Norway is developing into quite a commercial feature of that country, which is not otherwise very profitably endowed by Nature. One of our consuls in Norway, Vice-Consul Eyde, of Flekkefjord, reports: "The past year has shown eminent inclination for the purchase of waterfalls, and all our falls, both large and small, are already engaged by speculators. The waterfall Rafos, at the River Kyma, has been sold through Mr. Chr. Salvese, of Leith, to Herr Grätzel von Grätz, of Hanover, for a sum of £15,000. The fall is very large. An aluminium manufactory is said to be intended. The waterfall Struben, in the River Aaen Sire, is said to be sold for £8,300. Its intended use is not yet known." By the way, about 200 railway carriages are now lighted by electricity in Sweden, and in Denmark the same system is also in use on the better trains.

France and Submarine Cables.—Returning to the question of England's monopoly of the cable system (see p. 437, October 18), the *Débats* says that by geographical situation France should be the telegraphic centre of the world, and were the Government to take the matter resolutely in hand, Paris, in the course of time, would "outdistance everything as the general information office of the

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universe." The terms of the agreement which the French Government proposes to conclude with the Compagnie Française des Cables Télégraphiques for the laying, working, and maintenance of a new cable between France, North America, and the Antilles have been issued. The company is to lay a direct cable from Brest to New York, to renew, if necessary, the existing Pouyer-Quertier cable, and to extend both to the Antilles by an independent line from New York to Puerto Plata. The cost of the new cable is estimated at 30,000,000f., and the Government will pay an annual subsidy of 800,000f., or $2\frac{2}{3}$ per cent. on the capital outlay, until the returns reach 1,650,000f., or $5\frac{1}{2}$ per cent., when the subsidy will be reduced. With such terms as these the French company ought, at least, to be above the necessity of cutting rates in future, and to avoid the unpleasant suspicion which at present attaches to it.

North-East Coast Institution of Engineers and Shipbuilders.—At the invitation of Alderman T. Richardson, M.P., president of this institution, and Mrs. Richardson, some 700 ladies and gentlemen were entertained last Friday evening at a conversazione held in the Assembly Rooms, Westgate-road, Newcastle. The invited guests included Mr. W. D. Cruddas, M.P., Mrs. and Miss Cruddas; Alderman Hamond, M.P., and Miss Hamond; Mr. F. Flannery, M.P., and Mrs. Flannery; Sir E. T. Gourley, M.P., the president of the Institution of Mechanical Engineers; the foreign Consuls of the district; the Sheriff of Newcastle, Mrs. Sanderson, and Miss Sanderson; Sir Raylton Dixon, Middlesbrough; Mr. and Mrs. Wilson Worsdell, the president of the Hull Institute of Naval Engineers and Architects; Mr. H. H. Wake, engineer to the Wear Commissioners; Mr. P. J. Messent, engineer to the Tyne Commissioners; Sir Benjamin and Lady Browne, Principal Gurney and the professors of the Durham College of Science; the Mayors of Middlesbrough, South Shields, Cork, Hartlepool, and Jarrow; Mr. F. C. Marshall, Mr. Wigham Richardson, Mr. Robert Thompson (ex-president), Mr. Theodore Doxford, M.P., etc. The rooms were beautifully decorated, and from 7.30 to 8.50 Mr. Amers's Royal Exhibition Band discoursed a programme of music, and later played for dancing from 9 o'clock till midnight.

Electric Traction.—The report of the committee on electric traction appointed by the Association amicale des Ingénieurs électriciens has been published in Bulletin No. 4 of the association. The committee consisted of MM. M. J. Laffargue, F. Eschwège, A. Hattu, A. Hirtz, J. Sarcia, and A. Vernes. The report is divided into two parts, the first dealing with mechanical traction in general and going into the cost, etc., of the various systems. The conclusion is that the advantage rests with electric traction, and that that method will be increasingly adopted in the future. In the second part the different systems of electric traction are considered. Under the head of carriages containing their own supply of energy, descriptions are given of the old accumulator tramcars run from the Madeleine to Levallois-Perret in 1890, and the present tramways from the Madeleine to Saint-Denis, and from the Opéra and Neuilly to Saint-Denis, as well as those at Birmingham, Mount Vernon (New York), the Hague, and Vienna. The Heilmann locomotive is also dealt with. In the cases where energy is exteriorly supplied, the report considers the overhead and underground trolley systems. Mountain and mining work is also dealt with and accounts added of lines erected. In view of the importance of canal traction, the experiments of M. Galliot on the Canal de Bourgogne in 1895, and of M. de Bovet, on the Canal de Saint-Denis in 1894 are mentioned. The report contains altogether much important information methodically classified.

The Calomel Electrode. — The *Journal* of the Chemical Society gives an abstract of a paper by Mr. G. W. Coggeshall on this subject. A number of calomel electrodes were prepared in order to test their values and constancy at different times. The first set of experiments gave from time to time undoubted deviations from a constant value, and the form was slightly altered by placing over the mercury a quantity of sand grains, by which the surface of the calomel was increased and the saturation of the solution more completely insured. With these cells it was found that the E.M.F. during 40 days did not deviate from the normal value by more than 0·0008 volt. Experiments were next performed to test whether the size of the mercury surface affected the constancy of the electrode, the results being in the negative. The time required for the E.M.F. to reach its constant value was in most cases from 30 hours to two days. The effect of slight impurities was found by the use of commercial calomel and mercury, and although the purity of the mercury is of considerable importance, the commercial calomel is only very slightly inferior to the pure compound. It is hence possible to obtain a number of electrodes giving similar results, and the constancy of ordinary calomel electrodes may be regarded as within about 0·001-0·002 volt. The temperature influence was also determined, and the E.M.F. found to increase with the temperature; the coefficient between 0deg. and 25deg. being 0·000678, and between 25deg. and 50deg., 0·000647 (volt per degree), whilst the E.M.F. reaches its value in a few hours after the increase of temperature. The absolute value found by Rothmund was 0·561, a number Mr. Coggeshall considers as probably correct.

Spectra of Argon and the Aurora Borealis.—M. Marcellin Berthelot has been experimenting with mixtures of argon and benzene vapour, and with a view to procuring a combination has submitted them to the action of the silent discharge. According to *Comptes Rendus*, under the particular conditions of the discharge known as "rain of fire," there is developed an intense greenish-yellow fluorescence, the spectrum of which shows lines and bands in the yellow, green, blue, and violet very similar to those observed in the spectrum of the aurora borealis. Some of the bands are crossed by black absorption lines, owing to the thickness of the fluorescent layer. It is suggested that the aurora borealis may be due to the production of a fluorescent modification or compound of argon under the influence of atmospheric electricity. M. Berthelot says that pure argon, when mixed with benzene vapour, and subjected to the action of the silent discharge, undergoes very little change of volume, and the condensation previously observed was probably due to the presence of nitrogen as an impurity. With a coil connected with a Leyden jar and giving a spark 10mm. to 12mm. in length, the mixture of argon and benzene vapour becomes luminous after a time ranging from 15 minutes to four or five hours. It has a violet tint with a reddish "rain of fire." After some time the fluorescence becomes much more brilliant, and the colour changes to a brilliant green, and finally to blue. When this point is reached the fluorescence will continue for several hours, but after a long time, especially if the intensity of the spark is increased, the fluorescence disappears, and only a very feeble luminosity remains. If at an earlier stage the discharge is interrupted the fluorescence at once disappears, but on again completing the circuit it reappears, either immediately, or after a time increasing with the time that has elapsed since the interruption of the discharge.

Electricity in Chemistry.—A new process for the manufacture of caustic soda and bleaching powder, which, it is claimed, must produce great changes in the conditions

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under which the industry is at present carried on, is announced. It is the invention of Mr. Hamilton G. Castner, the chemist who brought out the method for the production of aluminium which was worked at Oldbury, near Birmingham, by the Aluminium Company, which controls the new system referred to. Hitherto caustic soda and bleaching powder, which are the chief products of the works in the United Alkali Company or Chemical Union, have been produced by the old Leblanc process, which is as old as the year 1791, but has since from time to time been improved. By this process, however, it is found difficult to produce caustic soda for less than £6 or bleaching powder for less than £5. 10s. per ton. The Castner method, it is said, reduces the cost of manufacturing caustic soda to £4. 5s. and of bleaching powder to about £3 per ton, so that it is apparently much more economical. But this is not all. The ordinary quality of caustic soda corresponds to what is technically known as 70 per cent. Liverpool test, whereas the soda produced by the Castner process is stated to answer to 78·5 per cent. Liverpool test. The fundamental feature of the new system is the employment of a moving body of mercury, which helps the electric action, forming an amalgam which is decomposed electrically as soon as it is formed. The cells employed are different from any hitherto suggested, and, it is stated, only one-fifth of the size used in any other process, actual or proposed. The great feature of the new method is said to be that it requires very little labour, being for the most part automatic. The Aluminium Company have been working the process experimentally at Oldbury for about a year, and, we understand, are now about to build large works in order to manufacture caustic and bleach.

Hysteresis.—In connection with an article on the law of hysteresis by Herr Chas. Proteus Steinmetz in the *Elektrotechnische Zeitschrift* of September 26, Herr Rob. M. Friese gives the following supplementary piece of information in the last number of that journal. It consists of three remarkable results obtained in the ordinary investigations in the iron-testing department of the Elektrizitäts A. G. vorm. Schuckert und Co. In the chemically almost identical specimens the values of η considerably differ. The Steinmetz formula is $H = \eta B^{1.6}$, where H is the loss of energy per cubic centimetre produced by hysteresis. Annexed are the results of the chemical examination of three ingot-iron plates, which came from various German works, together with the corresponding values of η:

	Plate I. (No. 297)	Plate II. (No. 245)	Plate III. (No. 278)
$\eta \cdot 10^3$	1·62	1·81	4·30
	per cent.	per cent.	per cent.
Total foreign substances	0 4473	0 3332	0 9035
Carbon	0·0967	0·2074	0 2906
Graphite	0·0096	0·0076	0 0113
Sulphur	0 0732	0 0160	0·0985
Silicon	0·0020	0·0230	0·0112
Copper	0·1776	0·0310	0·1003
Lead	Trace	—	Trace
Zinc	Min. trace	0·0032	Min. trace
Manganese	0·0395	Trace	0·3610
Nickel	0·0487	—	Trace
Calcium	Trace	0·0450	0 0306
Aluminium	Not referable	Trace	Not referable
Phosphorus	„	Not referable	„
Arsenic	„	„	„

The smallest value for $\eta \cdot 10^3$ hitherto observed at Schuckert's was 1·38. This was plate No. 115, from a Swedish ironworks. The greatest value for $\eta \cdot 10^3$ was possessed by plate No. 77, from a German ironworks, with 6·94.

Electricity in Gold and Silver Mining.—A recent article on the application of electricity to gold dredging illustrates another of the numerous applications of electricity. In this case, on account of the high price of fuel, the wealth known to exist could scarcely have been realised by any other means, and in no event with anything like the same convenience. The gold and silver mining regions, a Transatlantic contemporary remarks, furnish ideal conditions for the use of electrical power, and we may expect vast extensions of such use as the success of pioneer installations becomes plainly evident, particularly of those employing polyphase systems. In probably few mining districts is there any lack of water power within a reasonable distance, and where the system of mining requires any considerable quantity of power, electricity is the obvious source and by far the most convenient agent, from its ease of application to all manner of work. Owing to the conditions in many places, the pole line is a weak point where the power has to be transmitted a considerable distance, but this can be overcome by cheaply installed systems of underground transmission, which, however, do not always seem to have been considered. In Europe it has been found that cables simply buried in a trench over a porous bed (sand always being used there as the bed) give better results than the most elaborate conduit system, and the same method could, of course, be applied in many cases in mining regions where a long pole line would introduce an element of unreliability during certain seasons. Owing to the great amount of thought now being devoted to the subject of electrometallurgy, it may be that methods will be devised whereby precious metals will in most cases be directly extracted by electricity from ores as they come from the mines, or at least the valuable minerals so concentrated as to greatly reduce carriage costs. At present the electrical method of refining from concentrated products reduced by heat is in large use, and if the first step could also be accomplished by electrical means enormous savings in shipment charges would be effected. With the great water powers existing in the mining regions of the Far West, and the absence of cheap fuel, the field for the employment of electrical energy there is one which should result in vast developments.

Supposed Faults of Multiphase Systems.—In a paper read at the Ottawa Convention of the Canadian Electrical Association on "Some Modern Alternating-Current Apparatus," it is stated that multiphase systems are subject to the serious disadvantage that the circuits must be kept balanced. As the author follows up the statement by advocating in fulsome terms a competing system which is declared to have all the advantages of all other alternating systems and none of their disadvantages, his point of view can scarcely be considered disinterested, but is none the less mischievous. Through like statements made on similar occasions, the *Electrical World* of New York says, an impression has been created and widely extended that multiphase systems are impracticable for general use, for the reason that their several circuits will not admit of being unbalanced. While it is true that theoretically perfect conditions are only attained when such circuits are in balance, it is also true that multiphase systems will operate entirely satisfactorily within the limits that are likely to exist with respect to balance in any practical installation. We will add that we make this statement on the best of authority, and it is, moreover, upheld by the verdict of practice. At the Cleveland Convention of the National Electric Light Association, a central-station man operating a two-phase system said that no trouble had been experienced when one of the two circuits—each of which carried

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both light and power—had a load 50 per cent. greater than the other. At an exhibition of a two-phase system, several months ago, the circuits were so arranged that the loads could be unbalanced 20 per cent., and no effect on the lights was noticeable when such a change was made. It is in one respect unfortunate that the phenomena of alternating currents have become well known, for the general knowledge now possessed with respect to them is apt to be misapplied, to the detriment of the industry. If in the days when the simple alternating current was first introduced the phenomena of inductance and hysteresis had been well known, the growth of the alternating-current industry would probably have been seriously retarded, for how wisely would it have been argued that, in competition with the system then in use, there would not be a ghost of a chance for one whose regulation was handicapped by both inductance and transformer drop. Not being withheld by the existence of such doubts, the alternating people went ahead and produced results that were satisfactory from a practical standpoint. Even at the present day a theoretical consideration of the disadvantages of the simple alternating system with respect to regulation is likely to raise doubts which, however, are as soon dispelled by a remembrance of the fact that, grave as the objections may seem to be, they have no weight in practical working.

Indiarubber.—In the August number of the *Bulletin de la Société d'Encouragement* M. Chapel has an article on the progress of the indiarubber industry, which has been the consequence of a continually increasing demand for this substance. The most important source of indiarubber supply is Brazil, and the annual production of the best-quality rubber derived from that country, and known as Pará, has risen from less than 17,000 tons in 1889 to rather more than 20,000 tons for the year 1894. America also sends to the market the sorts known as Pernambuco, Ceara Scraps, Peru, Guatemala, etc., but the importance of these consignments shows considerable variation, and these qualities of rubber have a tendency to disappear. The supply from Africa has been largely influenced by the work of explorers during the last 20 years, but it is principally from the Congo basin that new varieties of rubber have reached us, coming down both to the West Coast and to factories on the shores of the Indian Ocean. From the West Coast we get Kassai and the little black balls with a white centre known as African-Equator. It must be remembered that among these new sorts there are several which have nearly the same character as rubbers that we used to receive under different names. From the Congo district come also Lopori, Congo cakes which are nothing else than what were formerly called Congo balls made up in a different shape, and also Red Kassai, which has a very strong resemblance to Loanda prima. Under the name of Upper Congo there also reaches us from the West Coast a rubber that was formerly known as Mozambique. Madagascar rubbers have received an addition under the name of Madagascar Niggers. This is a good rubber, in quality resembling Loanda, but having the horny appearance of Ceara Scraps. It, however, contains much earth. Nothing certain is known of its botanical origin. From New Zealand have come some packages of a rubber which appears very elastic, but which does not bear cutting up well. It is the produce of the banyan (*ficus religiosa*), and the rapidity and facility with which this tree reproduces itself may make it important in view of the wasteful methods adopted by the natives, who in many places practically destroy the tree to obtain the rubber. After urging the desirability of further trials of the *manihot glaziovii*, M. Chapel turns to the improvemen and economy in the manufacture that has been effected by the adoption of larger rollers. It is at present impossible to completely eliminate the sulphur contained in vulcanised indiarubber, and all processes for the remanufacture of old rubber are more or less unsatisfactory. Nevertheless, in spite of the continually increasing demand, the tendency is to seek a good appearance and a low price rather than to produce an article that shall have the solidity and durability of the old-fashioned indiarubber. Again, from another source, we learn that the newly-developed production of indiarubber in Lagos promises soon to attain important dimensions. In 1893 no imports of this article were recorded as received from the colony, and last year the amount was only £5,994. By a single steamer which left Lagos at the beginning of last month, however, the value of the indiarubber shipped to Liverpool was £15,000. The new industry appears to have given rise at Lagos to some excitement resembling that which is often occasioned by a new gold discovery. Numbers of clerks, small traders, and others, including, it is said, even professional men, have gone into the interior to profit by the collection and manufacture of the gum. The native owners of the forests are, however, insisting upon the payment of royalties, and some of them are themselves entering into the business of preparing the rubber for the market. Prices in the interior have been considerably advanced, and there is no longer so much profit as there was at first in purchasing and transporting it to the coast. Some fear is expressed that the ordinary trade in palm oil and palm kernels may suffer from the diversion of labour to the fresh industry, and that the supply even of indiarubber itself may be threatened by the indiscriminate tapping of immature trees. It is suggested that the Colonial Government should take steps to prevent the spread of the last-named evil.

The Berliner Telephone Cases.—A writer in *Electricity* of New York has carefully investigated the points involved in the Berliner disputes, and his elucidatory remarks on the subject may be interesting to readers on this side. He says: There are really two Berliner cases now occupying the attention of the telephone world. The first has reached the third and final stage, and had its origin in the bill in equity filed by the Attorney-General of the United States against the Bell Company on February 9, 1893, in which it was alleged that the Berliner transmitter patent of November 17, 1891, was an illegal grant and it ought of right to be annulled. The decision of Judge Carpenter of the Circuit Court of the Massachusetts district and the subsequent reversal by the Circuit Court of Appeals are of too recent occurrence to require further mention. A few weeks ago the decision of the Court of Appeals was appealed to the Supreme Court of the United States. The case has been docketed at Washington to be heard in the regular course. To rightly understand the situation, it must be borne in mind that the decisions already rendered in the Government suit on the Berliner patent have not determined the validity of the patent. The reversal of Judge Carpenter simply rehabilitates the patent, leaving it on an equal footing, before the law, with any other patent owned or controlled by the Bell Company, or by anyone else. The second and more important of the Berliner cases is the suit of the Bell Company for an order to restrain the National Telephone Manufacturing Company, the Bay State Telephone Company, and the Century Telephone Company of Boston from alleged infringement of the Berliner 1891 patent. The bill of complaint was filed on August 6. At the hearing assigned for September 3, 30 days were given in which to file an answer to the bill of complaint. At the expiration of this time, on the

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3rd inst., an order was issued extending the time for filing answer until October 15. The granting of an injunction in the Boston cases will, of course, affect directly and immediately only those companies against whom action is brought, but it is to be presumed—in fact, is so declared by the Bell Company—that similar action will be taken against not only other alleged infringers in the Massachusetts judicial district, but wherever found. The Berliner patent alone, if valid, practically controls commercial telephony so far as it is dependent upon microphones operating upon the constant-contact principle. We have always maintained, however, and still maintain, that commercial telephony is not dependent upon anything contained in the Berliner claims. The Bell Company have educated the public to believe that this patent is necessarily the sole key to the situation, but in our opinion this is a sheer fallacy. A new telephone exchange company, to be safe, however, should procure their apparatus of those manufacturers who are not only able but willing to guarantee their customers absolute immunity from damages for infringement of patents. The chief hope for the independent manufacturing companies lies in the defeat of the Berliner patent, because if that patent is out of the way the open field is much broader. Its validity can be successfully attacked in a properly prepared and conducted case. It is eminently desirable to the public that the Berliner patent should be defeated, but the sole recourse of the independent companies does not lie in its defeat. The old magneto instrument, the patent for which expired with the original Bell telephone patents, makes a far better transmitter than most people are aware. Good and distinct articulation has been given with this instrument over grounded circuits between New York and Cleveland and between New York and Chicago. If specially wound for long-distance transmission, its service over these distances could doubtless be far improved, and on metallic circuits be made even better than with transmitters of the variable-pressure type, as it already is for short distances. The public have been too willing to believe the dictum of the Bell Company that the variable-pressure microphone gives them the monopoly of the business or even gives them the best instrument. Even if the Berliner patent is sustained, the independents should not lie down, but should set their ingenuity to work to improve transmitters on the magneto principle until they attain an instrument that is in every way better than any now made on the principles covered by the patent in suit. Judged by the length of time other cases have been awaiting disposition by the Supreme Court, the writer concludes, it may be two years before a decision is rendered. American courts of law are notorious for their protractions and delays.

The Electric Annealing of Armour Plates.—The application of electricity in the annealing of armour plates is discussed by Mr. W. W. Hanscom, chief electrical engineer of the Union Ironworks of San Francisco. The nickel-steel armour plates, as furnished to the later vessels of the United States Navy, are by the Harvey process hardened on the face to a depth varying from ½in. to ¾in. This face is such that it successfully resists the hardest steel drill that can be made, and, as it is required in the final location of the plate to drill and tap numerous holes in it, it was necessary during the hardening process to protect the desired places by preventing the carbonising material from coming in contact with them. The operation was not entirely successful, however, as it was found upon trial that, although a number of the plates were sufficiently soft to be worked, others immediately alongside were as hard as the unprotected portions. A number of attempts were made to locally anneal these hard spots by means of the oxyhydrogen blowpipe and other apparatus, the most successful being that offered by the Thomson Electric Welding Company, of Lynn, Mass. It was found impossible by other means than electricity to apply sufficient heat in a concentrated form to attain the desired results, as the large mass of metal surrounding conveyed the heat away as fast as it was supplied. An annealing equipment has recently been installed at the Union Ironworks for annealing the armour plates of the battleship "Oregon." The apparatus in general consists of an alternator, with its exciter, a rheostat, a transformer annealer, and the engine for driving the same. The engine develops, at 450 revolutions per minute, 55 h.p. The alternator and exciter are of the ordinary commercial type; the former, of 40 kilowatts capacity, has six coils on as many pole-pieces, the windings being in two series of three in multiple. The armature is of the toothed type, with six coils, connected in a multiple of three series of two. It is wound for an output of 135 amperes at 300 volts when making 1,000 revolutions per minute. A pulley on the end of the armature shaft drives the exciter, a D-type shunt-wound generator of 110 volts at 2,000 revolutions per minute. Its terminals are connected to alternator fields through the regulating rheostat, a cylindrical frame, having German-silver coils cut into or out of circuit by a contact-arm on top. The coils are protected from mechanical injury by the wire-gauze covering, which arrangement permits of a constant circulation of air. The transformer annealer is of the shell type, and consists of an outer core of laminated iron surrounding both primary and secondary coils, the former being wound on a form and encased inside the latter, which is a hollow copper casting made in halves to receive it, and then bolted together, after which the remaining space is filled with oil for insulation and as an assistance in conducting away the heat generated in the primary. The secondary coil has but a single turn, U-shaped, to the ends of which are bolted various-shaped copper contact-pieces, which are hollowed and connected to a water circulation, thus preventing the heat of annealing from reaching the coils. The yoke from which the transformer is suspended by two trunnions, as well as the before-mentioned contact-pieces, permit of the transformer being swung into any desired angle and brought against any part of plates already located. In the operation of annealing the contact-pieces are brought up against the brightened surface of the plate and wedged into position, straddling the spot to be annealed, after the rheostat has been adjusted to a point reducing the primary current to a minimum. When the contact is established between the contact-pieces and the plate a slight humming noise notifies the operator, and the primary current is gradually raised to its maximum. A bright-red spot then appears under each contact-piece. The intense local heat at these spots causes the plate to expand outwardly in the direction of least resistance, forming slight mounds, from which circles of a gradually changing colour slowly approach the centre. The primary is kept up until the plate has become sufficiently heated to char or even ignite a pine stick held against it, and is then gradually decreased until it has again reached the minimum. The first or heating period requires about three minutes, during which the secondary current has reached from 3,500 to 6,000 amperes at four volts. The second or cooling period requires from 10 to 12 minutes, in order to prevent the sudden chilling of the spot due to the surrounding mass of metal and to ensure a perfect anneal. The plate at the spot of annealing presents a dark-blue colour, elliptical in shape, with a major axis of 4in. and a minor axis of 2½in., and is very readily drilled and tapped.

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THE ELECTRIC LIGHT STATION OF THE EMPIRE OF INDIA EXHIBITION.

RECEPTION OF ENGINEERS BY MR. JAMES N. PAXMAN ON OCTOBER 23, 1895.

A contract for the supply of power to this installation was at the end of last year awarded by the London Exhibitions Company to Messrs. Davey, Paxman, and Co., of Colchester.

The lighting of the grounds and of the various buildings comprised in the Empire of India Exhibition, which was arranged by, and is under the charge of, Mr. Guy C. Fricker, calls for some 260 arc and 800 incandescent lamps, and, seeing that the installation is for a number of years, it has assumed quite the character of a small "central station." The exigencies of the case, however, call for two systems of driving, so that a part of the station is devoted to a belt-driven plant, and part to direct-coupled high-speed engine plant. Altogether there are eight belt-driven dynamos, all of the Brush Electrical Engineering Company's manufacture, but of various descriptions—viz., one 75-kilowatt Mordey alternator, five 55-light Brush arc machines, one 40-kilowatt low-tension machine, one 20-kilowatt low-tension machine. These are driven by two compound engines of Messrs. Davey, Paxman, and Co.'s well-known "Colchester" type, capable of developing 250 h.p. and 120 h.p. respectively, and one of their compound coupled girder engines capable of developing 120 h.p. All these engines are fitted with Paxman's patent automatic expansion gear. This plant is evidently doing excellent work. The engines, however, are so well known that no detailed description of them is necessary.

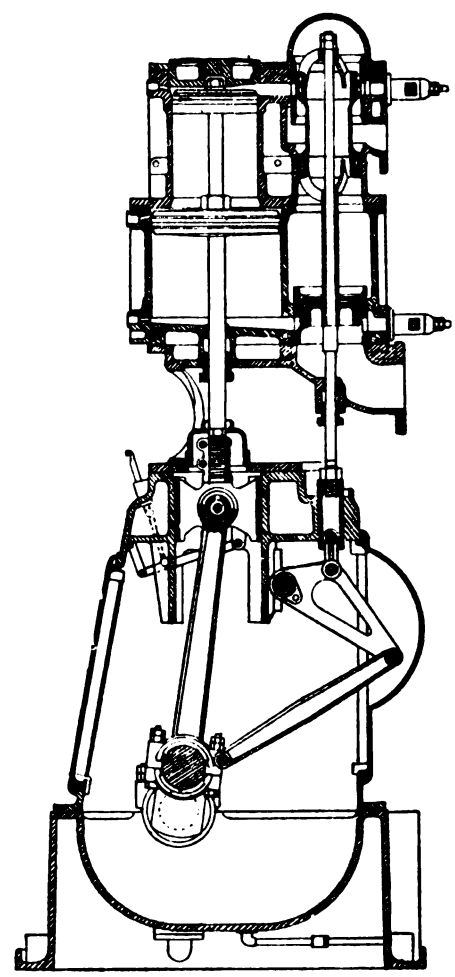
The chief interest centres in the high-speed single-acting engines, which are a new departure in Messrs. Davey, Paxman, and Co.'s practice. These are Peache's patent high-speed compound engines, two of which are three-crank engines, with three sets of compound cylinders 10in. diameter and 15in. diameter by 10in. stroke, arranged tandem over each crank. Each engine is coupled direct to a 100 kilowatt Mordey alternator, and runs at 325 revolutions per minute, developing about 220 h.p. each. The third is an engine with cylinders of the same size, but with two cranks only, set at an angle of 180deg., coupled direct to a 75-kilowatt Mordey alternator, running at 355 revolutions per minute, and developing about 150 h.p.

The engines run very silently, and there is no vibration perceptible. The governing is very close, being within 2 per cent. from full to no load, and yet there is no unsteadiness or tendency to "hunt." This is especially noticeable in the two-crank engine coupled to the 75-kilowatt alternator, which supplies the Empress Theatre lighting. In the exigencies of the theatre lighting, 90 h.p. to 100 h.p. is during the evening thrown off and on, often being nearly the whole load on the engine at the time, but the governor handles this with the greatest promptness and without any perceptible change in the speed of the engines. A further description of these engines will be interesting.

The first of these engines were started in January of the present year, and since then the three engines for the exhibition have been made and were set to work with the opening of the exhibition in June. These engines have proved themselves to be thoroughly satisfactory in every respect, and embodying, as they do, some novel features of great practical importance, together with thoroughly sound mechanical construction, they deserve the attention of those interested in the direct driving of dynamos and other high-speed machinery.

Referring to the sectional view given herewith, it will be seen that the high and low pressure cylinders are arranged tandem over the crankshaft. The crankshaft, instead of being placed in line with the cylinders, as usual, is placed out of line to the extent of the throw of the cranks. In a single-acting engine this is the right position for the crankshaft, for the crosshead slide is thus rendered single acting, and, moreover, the pressure on it is relieved; for during the down stroke, when the pressures are heaviest, the connecting rod is straight or inclined at a small angle, while on the up stroke, when the angle of the connecting rod is considerable, the pressures passing through the crosshead are at a minimum. In addition to the above reasons for justifying the unusual position of the crankshaft in the present case, it enables a very simple form of valve gear to be adopted, doing away with eccentrics, and thus giving room for large and compact bearings.

The distribution of steam in the engine is effected by a line of piston valves. Steam is admitted under the high-pressure valve to the top of the low-pressure piston, thence it is exhausted over the top of the high-pressure valve and through the centre of that valve to the receiver space. From there, it is admitted over the top of the low-pressure valve to the underside of the low-pressure piston, and finally under the low-pressure valve to the exhaust. The holding down of the line of pistons on the up stroke is effected by the compression of steam in the space between the high-pressure and the low-pressure cylinders, called the controlling cylinder; this steam is again expanded on the down stroke.



Sectional View of Peache's Engine.

A very small by-pass port is provided, which is uncovered by the high-pressure piston at the top of its stroke, and which for an instant forms a communication between the top and the bottom of the high-pressure piston. This provides for the supply of any fresh steam which may be needed to maintain the supply of steam in the controlling cylinder, and here attention must be called to an important feature in the provision of the holding-down power, and one which is peculiar to this engine. The controlling cylinder diagram can be arranged so that it expands below the pressure of the steam in the low-pressure cylinder, and, consequently, on the first half of the up stroke, instead of the inertia of the reciprocating parts having to be overcome by power transmitted through the crankshaft, as is the case in other single-acting engines, it is overcome by the excess power developed on the underside of the low-pressure piston. The effect on strains in the crankshaft and friction on bearings is apparent.

It may be said that steam being used in the controlling cylinder must mean loss from condensation, but the position of the controlling cylinder in this engine must be remem-

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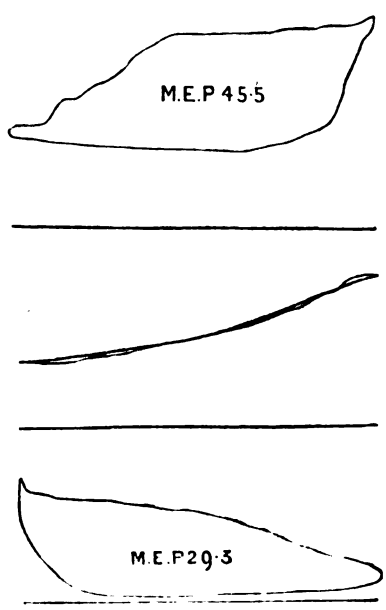
bered—viz., between the high-pressure and low-pressure cylinders; and it is contended with reason that any heat passing from the steam in this cylinder does good work in heating up the walls for the following steam stroke in the high-pressure and low-pressure cylinders; and, in fact, with superheated steam or with superheating coils in the controlling cylinder, it is contemplated that the controlling cylinder may become the most efficient "steam-jacket" possible—viz., one that heats up the working surfaces in the working cylinders. The valves are shown arranged to be held down by the receiver pressure steam, and usually this is satisfactory, but, in cases that require it, a modification of the controlling cylinder can be applied.

The diagrams are reproduced from one set of a number taken from the first engine built during a six hours' steam trial at Colchester on July 26, 1895. The engine was run on the brake, and gave a consumption of 22lb. of steam per indicated horse-power, 88 per cent. of the indicated horse-power being measured on the brake. The boiler pressure available was 130lb.; there were sundry small leaks, and the steam was taken direct from the boiler to the engine without a separator being interposed, so that no doubt the engine did not get all the feed water that was debited to it as steam. The engine, too, was arranged as it would be in practice—viz., with a cut-off sufficiently late to give high M.E.P. (49·8lb. in this case with 130lb. boiler pressure), and not with a comparatively early cut-off—so



Diagrams taken from Peache's Engine

as to give a specially low steam consumption per indicated horse-power. These diagrams have been reproduced, therefore, not as a measure of the efficiency of the engine; but to give an idea of its working.

Special attention has been given to sound mechanical construction. The crankshaft, as it should be in a single-acting engine, has been made of ample strength—viz., one-third the diameter of the low-pressure cylinder. All bearings are very ample, and all parts are simple and strong. Consequently the engine will stand readily any pressure that can be brought to bear on it, whether for short or long runs. Every part is as easily accessible for examination or removal, as in an ordinary double-acting engine. There are no internal glands, and of the two external glands, one is exposed to the steam in the low-pressure cylinder only and the other to exhaust pressure steam only.

The advantages of the three-crank type of engines are so great, both on account of absence of vibration and evenness of turning, that Messrs. Paxman have adopted that as their standard type of engine.

The plant has been put down without allowance for spares, and during the evening all the engines are loaded; the confidence thus displayed by the London Exhibitions Company in their contractors—Messrs. Davey, Paxman, and Co.—being justified, for there has been no failure or hitch with the running of any of the engines.

Steam is supplied by a battery of nine of Messrs. Davey, Paxman, and Co.'s locomotive-type boilers, each having 710 square feet of heating surface and 19½ square feet of grate area, and each being easily capable of supplying steam sufficient for 120 h.p. The flanging of the steel plates by the very complete hydraulic plant at Messrs. Davey, Paxman, and Co.'s works, Colchester, is excellent, and, generally, the boilers are a fine example of boiler work.

A large number of guests sat down to dinner, which was well served by Messrs. Spiers and Pond. Only one toast was permitted, and that was proposed by Sir F. Bramwell, "Our Host." This was drank upstanding, and after a few words of reply the guests adjourned to the Empire of India Theatre to witness the spectacular performance under the direction of Mr. Kiralfy.

MUNICIPAL ELECTRIC LIGHTING ACCOUNTS.

At the meeting of the Association of Municipal Corporations held last Friday at the Westminster Palace Hotel, S.W., Sir Albert Rollit presiding,

The Town Clerk of Southport moved, "That a request be addressed to the Board of Trade from this association to promote a Bill in Parliament for the purpose of amending Section 9 of the Electric Lighting Act, 1882, so as to provide that the annual statement of accounts therein referred to should be made up to March 25 instead of December 31." The mover said that the object of the resolution was simply to provide that the electric lighting accounts should be made up to the same date as the other accounts instead of to a different date. It had been suggested that March 31 would be a better date than the 25th.

The Town Clerk of Wolverhampton seconded the resolution. He understood that the Board of Trade would be quite willing to take the matter into consideration. With regard to the form of the resolution, as it was a difficult affair when once a date was fixed by Act of Parliament to get it altered, he would suggest that the resolution should be "to such a date as the council may fix with the approval of the Board."

The resolution having been amended to this effect was carried unanimously without further debate.

DEY-GRISWOLD HYDRAULIC GEAR.*

Much thought has been expended in attempting to devise some form of gearing of electric railway motors that will enable the motor to run continuously and prevent the great waste of energy which now takes place in starting a car. The actual horse-power expended in starting a car is not large. While the horizontal effort is great the speed is low, and as horse-power is speed multiplied by horizontal effort the horse-power is low. The object then has been to devise a gear which will allow the motor to run at full speed and make use of all its available horse-power in the process of starting. The useful horse-power exerted by an electric motor in starting a car is only a small fraction of the energy that is consumed by it in so starting. The balance is wasted in heating motors and resistance. Various forms of gearing have been proposed to overcome this. The electrical method devised by H. Ward Leonard several years ago accomplished the end, but the apparatus necessary added so much to the cost, weight, and complication of the machinery on a car that it has never found favour.

Harry E. Dey, of the Dey-Griswold Company, has attacked the problem with a hydraulic gear. The motor is put in the centre of the truck, and drives a set of pumps filled with oil, which is piped to fluid motors on each axle, and so drives the car. The motion of the car is therefore dependent on the motion of the pumps, and it is manifest that when the pumps are operated with a very short stroke (although at constant speed) an immense effort can be exerted at a slow car speed as in starting, while for higher speed and less horizontal effort the stroke of the pumps can be increased. The most essential element of

* From the *Street Railway Review*.

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the whole arrangement is, therefore, the variable-throw crank, which connects motors to pumps. These pump cranks are on the motor axle, and can be given any stroke from zero to 3in.

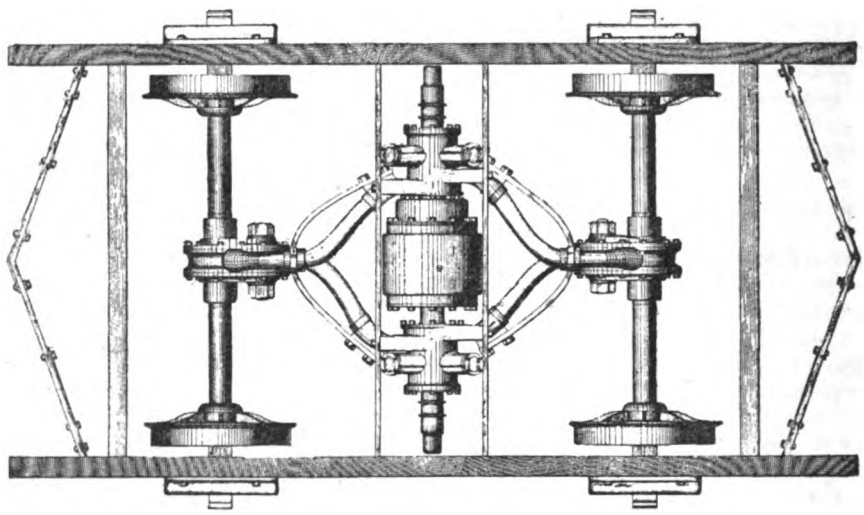

FIG. 1.

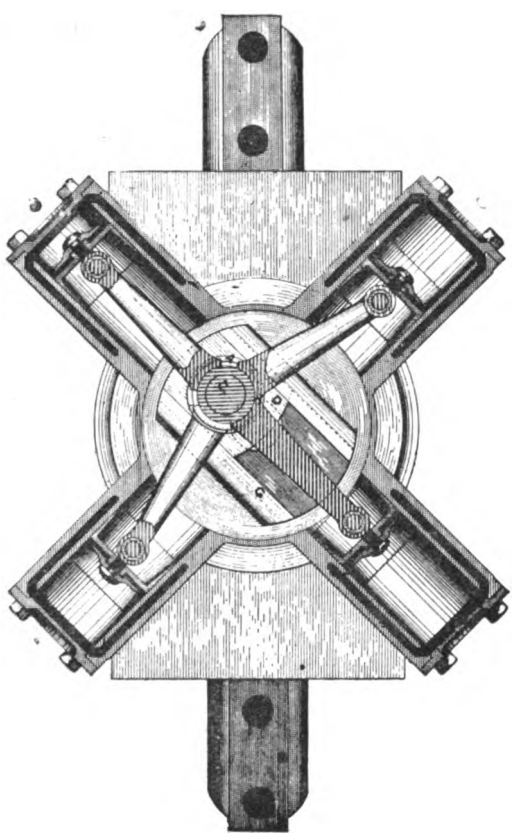

FIG. 2.

A general plan of the motor and hydraulic gear is shown in Fig. 1. Fig. 2 is a section through the pumps, and Fig. 3 a section through the fluid motor on the car axle. Fig. 4 is a section through the motor and pumps, and is the most interesting part of the apparatus. It will be seen that it is somewhat complicated. Both motor and armature revolve. The armature is connected to one pump, and the fields to the other. This gives a high inductor velocity to the armature with one-half the pump speed otherwise required. The fields are internal, and the brushes bear on the end of the commutator to avoid the action of centrifugal force. The length of the stroke of the crank is regulated by the motorman as follows: The crank, D E, slides in the dovetailed pieces, F G, which are fixed on the revolving axle. The crank has a rack meshing in the pinion, H. This pinion is keyed to the shaft, I, which has four high-pitch threads cut on it. The nut J threads on these, and also slides in a groove in K, which is an extension of the main shaft with which all of these parts revolve. A normally stationary nut, L, threaded on the outside has the nut J freely revolving inside of it, and kept in position by the collar shown. Working over the thread of the nut L is the sprocket nut N worked by a chain from the front platform.

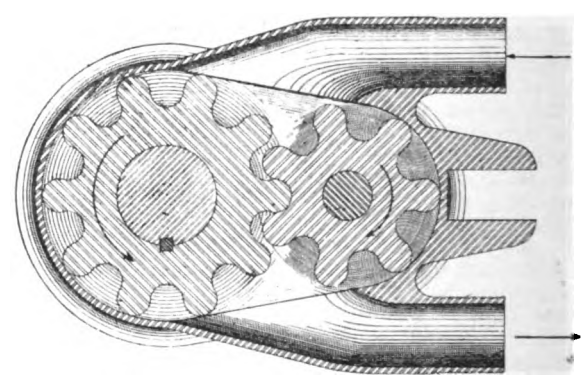

FIG. 3.

The motor is shunt wound, running at practically constant speed. When the car is to be stopped, the reverse process takes place from that when the car is started. The stroke of the pumps is shortened by the motorman and the fluid motors on the axles drive the pumps and

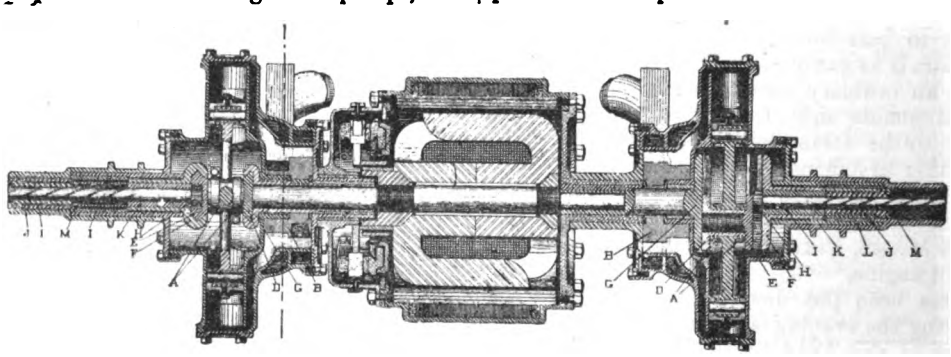

FIG. 4.

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increase the speed of the motor. As it is shunt wound, it gives back energy to the line and acts as an electric brake. This not only is useful in making stops, but returns energy to the line when going down hill. The motor need not be as large as the usual series motor, because it never has to do more work than required when the car is at full speed. The controller and rheostats are done away with. The Dey-Griswold Company, of which the inventor is president has recently been incorporated to do a general electrical manufacturing business.

THE ELECTRIC LIGHTING OF EDINBURGH.

BY HENRY R. J. BURSTALL.

The following paper was read at the Institution of Mechanical Engineers on October 23, Prof. A. B. W. Kennedy (president) in the chair.

The electric lighting of Edinburgh, as is also the case in many of the most important towns in England and Scotland, is in the hands of the Corporation, and was finally decided on late in 1893, when the work of designing and superintending the whole scheme for public and private supply was entrusted to Prof. Kennedy. Work was commenced at the station and in the streets in May, 1894, and the station was opened for the continuous supply of electrical energy on April 11, 1895, the exceptionally severe winter having seriously delayed the progress of the station buildings.

Districts.

From the electrical point of view the city of Edinburgh may be said to consist of two districts, differing from each other both in character and in their positions relative to the centre of the city. The older part of the city by the castle and the district north of Princes-street include the greater part of the business premises, together with a residential district in which the houses are large and closely built, and where the demand for current may be expected to be great. The district to the south and east of the central portion is either residential or of such a character that the demand for current can never be as large as that in the northern and central district. The residential part of this district contains many houses which stand detached from one another, thus diminishing considerably the possible number of lamps in proportion to the frontage. Having regard to the different districts to be served, and taking into account all the local circumstances, it was decided, after comparison of the various systems of supply and distribution which could be used, to adopt a low-tension three-wire system for the central and northern district, and an alternating-current high-tension system for the southern and eastern district, both systems being worked from one central station and under the same control and management. A good site was found for the central station between the Caledonian Railway and Dewar-place. The foundation here is rock, and the station being on the railway, coal is brought direct into the boiler-house in the railway trucks at a minimum of expense. The position of the site is such that, while being fairly central, it is in a neighbourhood where there is little chance of complaint as to nuisance, real or otherwise.

Station.

The building, which is a handsome brick erection with brown stone frontages to Dewar-place and Torphichen-street, is from the designs of Mr. J. Cooper, the burgh engineer, and was erected under his superintendence. The site is roughly triangular; the boiler-house occupies nearly the whole of the north side, and the two engine-rooms are parallel to and south of it; the general offices occupy the extreme south of the site, and are large enough for the accommodation of the whole of the clerical staff, as well as for the resident engineer and his assistants. Above the boiler-room are the workshops; and the floor above the western end of the engine-rooms is used for the battery-room, storeroom, and meter store and testing-rooms. The eastern part of the engine-room is covered with a light iron roof, with ample provision for light and ventilation. The boiler is covered with a concrete floor, which will ultimately be used as a coal-store. There is ample space in the buildings at present erected for considerable extensions without any extra outlay beyond the foundations for new engines and boilers.

Boiler-house.—The boiler-house is 158ft. long by 48ft. wide, occupying nearly the whole of the north side of the site. It is designed to contain 17 boilers, of which at present only the six at the west end are in place. The main flue runs along the centre under the stoking-floor into the chimney, which is placed in the centre of the length of the house, and is 8ft. square inside and 160ft. high, being lined with firebrick for a height of 60ft. The side flues from each boiler enter the main flue at a slight angle, and each flue is fitted with a butterfly damper; a damper is also placed in the main flue close to the chimney.

The boilers are of the dry-backed marine type, each 10½ft. mean diameter and 12ft. long, with two Purves flues, 3½ft. inside diameter, and 166 tubes of 3in. internal diameter. The boilers are of steel, with wrought-iron tubes, and have been built in accordance with Board of Trade rules for a working pressure of 160lb. per square inch above atmosphere. They are fitted with the usual mountings, and have duplicate feed-check valves.

On the top of the boilers are fitted superheaters, each consisting of two nests of tubes enclosed between the top of the boiler shell and a firebrick casing above, with a space left in the centre for the steam-valves, safety-valve, etc. Each superheater consists of 32 vertical flat coils of wrought-iron tube 1½in. diameter, running from a large cast-iron pipe at the back of the boiler to a similar pipe at the front, all joints being outside and protected from the action of the gases. The steam circulates from a standpipe on the boiler to the back leading pipe, through the superheating tubes to the cast-iron pipe at the front, and thence to the main steam-pipe; proper valves are arranged so that the superheater can be entirely shut off and the steam be taken direct to the main steam-pipe. Each superheater is fitted with a safety-valve and draining-cocks. The superheater coils are readily accessible for cleaning and examination by doors at the front and by movable plates at the top, or, if necessary, they can be lifted bodily away from the boiler. The course of the furnace gases is from the furnace to a brick combustion-chamber at the back of the boiler, through the boiler tubes to a wrought-iron smoke-box at the front, thence up and along the top of the boiler, past the superheater tubes to the back, and there down each side to a centre flue under the bottom of the boiler. A damper is provided, by which the gases can be sent direct to the sides of the boiler without passing the superheater tubes. Sinclair's mechanical stokers are fitted to each boiler, and are worked from two lines of shafting, which are carried by the columns of the boiler-house and driven by an electric motor.

Steam is taken from each boiler through a standpipe, with valves to the superheaters, and from the latter through a large copper bend to the main steam-pipe, which forms a complete ring round the present boilers. This ring joins the engine-room main at two points, and is provided with valves, so that the failure of any one pipe will put only the corresponding boiler out of use. Drain-valves are placed wherever water may accumulate, and are all connected to a steam-trap, which returns the condensed water to the feed-tank.

The pump-room is opposite the chimney, and is entirely closed in. It contains at present one duplex steam-pump and two three-throw pumps driven electrically; each pump has a maximum capacity of 4,500 gallons per hour. The electrically-driven pumps are specially designed to run with a large range of speed, and for this purpose can be connected with either the 230-volt or the 115-volt mains. The steam-pump has its steam supply connected with two points of the main steam-pipe, and its exhaust is connected with the feed-heater. Each feed-pump has an independent suction from the feed-tank, and two independent deliveries into two separate lines of pipes, each of which can be connected with either range of the two duplicate rings of feed-pipes, either through the feed-heater or direct. The duplicate rings of feed-pipes are carried round the stoke-hold in chases in front of the boilers, and each boiler is connected with both rings of pipes by separate feed-check valves delivering into a common internal pipe. A Kennedy water-meter is connected with one range of feed-pipes, so that the whole of the water going to the boilers can be measured. In the pump-room is placed the electric motor for driving the mechanical stokers with its countershaft, and there is ample space for more pumps when they are required.

Under the pump-room is the feed-tank, which communicates with a large storage tank at the end of the boiler-house; another feed-tank is also provided under the workmen's room, so that there is an ample reserve of water in case of accident to the water supply. A siding from the Caledonian Railway runs into the boiler-house, and the coal brought into the railway trucks is at present stored in the east end of the boiler-house. On the station being extended the coal will be stored over the boiler-house and let down through shoots to the mechanical stokers. In designing the plant at present in the boiler-house provision for extensions has been kept in mind, and the arrangements are such that new plant can be added at any time without interfering in any way with the working of that already in use.

Engine-rooms.—The engine-rooms are each about 102ft. long, and are side by side, forming really one room divided by a line of columns which carry the roofs and the beams for the travelling cranes. The engine-room next the boiler-house is reserved for the low-tension plant, and is 46½ft. wide. The other contains the high-tension plant, and is 41½ft. wide. A platform, raised 4ft. above the engine-room floor-level, runs the whole way across the west end of both engine-rooms, and on this are placed the switchboards and regulating gear for both the low and high tension systems, as well as the office of the engineer on watch.

Low-Tension Engine-room.—The machinery at present in the low-tension engine-room consists of eight engines—four of

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100 i.h.p., two of 250 i.h.p., and two of 360 i.h.p.—with their dynamos; and provision is made for eight more engines of 360 i.h.p. in the future. All are Willans central-valve engines driving their dynamos direct. All the dynamos are two-pole shunt-wound machines with drum armatures, all wound to give 270 volts, except two which are driven by two 100-i.h.p. engines; these two are wound to give 135 volts, being used as balancing machines on the three-wire system.

The steam-piping forms, with part of the boiler-house ring, a complete ring round the low-tension engine-room, and is connected with the boiler-house ring at two points. The main ring is 8in. internal diameter throughout; the straight lengths are of steel, with thick flanges screwed and brazed on; the tee-pieces and valve-boxes are of cast iron, and the bends of copper with steel flanges. All bends are of large radius, and no expansion joints are used or required. The engines are erected in pairs, and are connected with the main ring by two long copper bends; in the main ring a valve is placed between the branches to the two pipes, with a cross-over pipe and valve at the engines, so arranged that the engines can take their steam from either side of the valve in the main ring. The pipes are slung by long rods from brackets fixed on the walls or columns, so as to allow free movement.

In every section of the main ring are placed two drain-valves, one connected with a drain ring, which is common to half the drains, and is connected with a large steam-trap, whereby all condensed water is returned to the feed-tank. The other drain-valve is connected direct to the exhaust-pipe, and is used only on emergency, or when the steam is entirely shut off from that section of the pipes. The separators on all the engines are connected to a second steam-trap, which returns the water collected to the feed-tank; the drains from the cylinders, etc., are connected to the exhaust-pipe. The whole of the steam-pipes and valve-boxes, as well as the drain-pipes up to the steam-traps, are covered with non-conducting composition, and special non-conducting covers are fitted on all the flanges. In fact, every attempt has been made to reduce the loss by condensation in the steam-pipes, which forms so considerable an item in the losses that occur in central-station work.

All the engines are fitted with cooling-pipes in the crank-chambers, to which the water is carried in a line of pipe round the engine foundation block, and taken thence to the feed-tank by a second line. Each engine is fitted with a valve on the exhaust; the exhaust steam is led by a copper bend into the main exhaust-pipe, which is carried in chases in the engine foundation block and along the void between the block and the walls. The main exhaust-pipes are of cast iron, and are led through a Berryman feed-heater in the boiler-house to the chimney. Only one heater is fixed at present, but provision is made for three more when required. From the heater the exhaust steam is carried up to the top of the chimney by a vertical cast-iron pipe 21in. diameter. Valves are provided so that the exhaust steam can be carried direct to the vertical exhaust-pipe without going through the heater.

The whole of the machinery stands on a concrete foundation block 7½ft. thick, which is separate from the foundations of the walls. A void 3ft. wide is left at each side of the block, which is also stopped some distance in front of the switchboard platform, thus forming a large chamber at the west end of the two engine-rooms for the connections, etc. An eight-ton travelling crane, running the whole length of the engine block, is provided in each engine-room for convenience in overhauling, etc. These cranes are worked entirely from below by means of ropes.

Leads.—The main leads from the dynamos are drawn through curved wrought-iron pipes let into the concrete into chases in the centre of the engine foundation block, along which they are carried to the chamber under the switchboard platform. The leads from the field winding of the machines are also carried in the same manner to their regulating resistances, which are placed under the platform; the switches for these resistances are fixed upon the handrail on the platform in front of the switchboard, the leads from the resistances being brought up through the posts of the handrail.

Switchboard and Conductors.—The switchboard and the whole of the apparatus for regulating the dynamos and batteries, and for the distribution of the current, are placed on the platform, and are directly under the eye of the engineer in charge. The switchboard consists of seven slate panels, each about 7ft. high, and stands 4ft. from the west wall of the engine-room, thus allowing ample room to do any work on the connections, etc., at the back. The instruments and gear for regulating the battery are mostly placed on the centre panel, and those for the switching and manipulation of the dynamos and feeders are on the six outer slates; the connections for the positive side of the system are on the left hand, those for the negative on the right, and the middle wire is connected on the centre panel.

The arrangement of the switchboard and conductors is as follows: The feeders enter the building at a cellar under the pavement on the west side, and are brought along the wall under the platform in the form of heavy copper rods, which are carried on insulators, and pass up through the floor to their respective terminals at the back of the switchboard, and are attached to the terminals at the top of the board by cones and nuts. They are connected, through a duplex fuse and an ampere-meter, to heavy vertical copper bars on the front of the slates, each bar having three holes in it, through which plugs can be inserted. The leads from the dynamos are carried in the form of insulated cable to their respective terminals at the back of the board, near the bottom; and through fuses, automatic switches, and ampere-meters, are connected to vertical copper bars fixed to the front of the slates, similar and parallel to the feeder bars. The automatic switches are so constructed that the switch, after being closed by hand, is held in place as long as the current flowing through it exceeds from 15 to 20 amperes; should it fall below this, a trigger is released and the switch is automatically opened, thus breaking the circuit and preventing damage if a machine should fail from any cause. Three heavy copper "omnibus" bars are fixed horizontally at the back of the three outer slates on each side, and are capable of being connected to any of the feeder and dynamo bars of that side by means of heavy copper plugs, which are inserted through holes in the vertical bars and slates, and screw into the omnibus bars at the back, the contact being made on the front bars by a faced collar. The feeders under ordinary circumstances are all connected to the top omnibus bar, and are all in parallel. In order to connect any dynamo to the feeders, plugs are screwed into the top holes of the vertical bars corresponding with that dynamo, the brushes of the machine are put down upon the commutator, and the stop-valve of the engine is fully opened so that the engine is running on its governor; the switchboard attendant regulates the E.M.F. of the machine until it is equal to that shown on the voltmeter between the top bars, and then closes the automatic switch, putting load on the dynamo by taking resistance out of its field circuit. During the whole time the machine is on circuit it is regulated by the switchboard attendant, the engine running on its governor with the stop-valve full open; the engine-driver has to attend only to the running of the engines and dynamos. For the sake of economy, however, the engines are run somewhat slower at low loads than at full load; after about three-quarters of the full load has been reached, the setting of the governor is altered, and the engine run at full speed. In order to take the machine off circuit, resistance is put into the field circuit until the current falls so low that the automatic switch opens; the driver then lifts the brushes out of contact, and shuts down the engine.

Balancing Machines.—The foregoing description applies only to the high-volt machines; the connections for the balancing machines are somewhat different. The leads for each of these dynamos are connected—through fuses, ampere-meters, and automatic switches, as for the high-volt machines—to two contacts of a double-pole switch on the centre panel; and can be connected alternatively with two of three contacts, one of which is connected to the middle wire and the other two to dynamo bars on the positive and negative sides of the switchboard respectively. Thus each balancing machine can be put between the middle wire and either the positive or the negative side of the switchboard. These machines are run in exactly the same manner as the high-volt machines, and the whole of their regulation is done from the switch platform.

In the circuit of each dynamo is a registering ampere-hour meter, from which are taken readings whenever the machine is started and stopped, and the station records of the units generated are made up from these readings. Voltmeters are provided, which can be connected to the terminals of each dynamo by means of multipolar switches; other voltmeters are also connected, so as to show the E.M.F. between any of the omnibus bars on the positive and negative sides, and also between the omnibus bars and the middle wire. A pair of voltmeters are fixed on the upper part of the centre slate, and are connected through multipolar switches, so as to show the pressure between the middle wire and the positive and negative wires respectively at any feeding point on the system, and for this purpose light wires are brought back from the feeding points. The switchboard attendant is thus able to know directly the E.M.F. on the distributing mains, and regulates the E.M.F. at the switchboard so as to keep this constant.

The two lower horizontal omnibus bars can be connected by plugs to any feeder or any dynamo; by this means it is possible to run any feeder or feeders at a higher or lower E.M.F. than the others, should occasion arise. The same two bars are also used for testing and for the introduction of standard instruments into the circuit of any feeder, dynamo, or battery, for the purpose of checking or calibrating the switchboard instruments without breaking any permanent connections or running the circuit on temporary connections. The instrument or standard resistance, etc., is connected between two of the omnibus bars, and the dynamo or feeder, etc., is plugged on one of the lower omnibus bars; the current passes through the resistance, etc., to the top bar, which is on the outside circuit. In the actual running of the station considerable use is made of these spare omnibus bars.

Battery.—In ordinary circumstances the two outer ends of

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the batteries are plugged on to the top omnibus bar on the positive and negative sides of the switchboard, but can be disconnected either by removing the plugs or by the emergency switches. One of the cells near the inner end of each battery is connected with the middle wire through the regulating switch. Save under exceptional circumstances, however, the E.M.F. of the whole battery in series would be much too high for the circuit, and therefore by means of a regulating switch any number up to 26 of the inner cells of each battery can be put in parallel with the inner cells of the other battery, thus keeping the E.M.F. of the battery the same as that required at the omnibus bars to which the feeders are connected. When the dynamos are running the battery-regulating switch can be set so that no current is passing into or out of the battery; putting more cells in parallel will lower the E.M.F. of the battery, which will then be charged by the dynamos, while putting fewer in parallel will raise the E.M.F. of the battery, and cause it to discharge and thus to help the dynamos. Under normal circumstances the battery is charged while the load is light, more or less current being put into the battery as the load on the external circuit varies, so as to keep the engines running at that time as fully loaded as possible. During heavy load the battery is kept as far as possible with no current going either into or out of it; only after the dynamos are stopped is it discharged at all heavily, or when the load suddenly rises, and then only for short intervals. This method of regulating the battery by putting the centre cells in parallel, which is due to Mr. B. M. Jenkin, necessitates connecting up to the regulating switches more cells than the usual arrangement of regulating by cutting out cells on the outer end of the batteries; but it renders the manipulation of the battery much more simple, and does away to a great extent with the somewhat troublesome charging of the back cells—that is to say, the cells at the outer end of the batteries—which also in the usual arrangement may be used for only a few hours, or even only a few minutes in the day, while they have always to be charged and kept ready for work.

Battery Connections.—The connections to the battery are shown on the diagram, whereon is roughly indicated the actual manner in which the switches, etc., are arranged. The connections may appear somewhat complicated, but in actual work the regulation of the battery is effected by moving only one wheel, like a steering-wheel, fixed on the middle slate of the switchboard. The switches themselves are placed in the battery-room above, and are worked by wire ropes from the wheel below. A special circuit and switch is provided, by which the cells that are in parallel can be charged independently of the rest of the battery; but in actual work this is not regularly used. In this arrangement of battery regulation the whole of the cells in the battery are always used, but the centre cells are not charged or discharged to such an extent as those which constantly remain in series. By properly choosing the time of charging, the regulating cells can receive rather more charge than they discharge; and in order to enable the charging to go on at light load when there is only a small drop on the feeders, the "hospital" or "milking" cells are connected up, as shown in the diagram, four on each side of the system, through two small switchboards on the switch platform. By suitably arranging the switches these cells can either be put in series with the main battery, or be put between the dynamo charging the battery and the feeders; in the latter case, part of the current goes to the battery and part on to the circuit. The E.M.F. of the dynamo charging the battery can thus be made higher than that required at the station end of the feeders, and the battery can be charged with more of the regulating cells in series than would be possible if it was in parallel with the circuit. This arrangement has the additional advantage that full use can be made of the hospital cells, which are usually standing idle unless any cell in the battery requires assisting. When used for this last purpose, the hospital cells are cut entirely off the circuit, and are put, two in series, in parallel with any cell which shows signs of weakness during the discharge of the main battery; connections are made from the hospital cell switchboards in the engine-room to terminals in the battery-room, and adjustable resistances and ampere-meters are put into each of these circuits, so that the current passing from the hospital cells to the weak cell can be regulated, and is always under control of the switchboard attendant.

Battery-room.—The battery-room is directly over the west end of the low-tension engine-room, and is reached by a spiral staircase directly from the switch platform. It has a fireproof floor covered with acid-resisting asphalte, and is well lighted and ventilated, having windows on both sides of the room, as well as a ventilator in the ceiling. The battery consists of 132 cells of the new Crompton-Howell 31-plate type. It is divided up into two half-batteries—positive and negative—and is arranged in two tiers on four rows of stands, which are of cast iron with wooden longitudinal bearers carrying the cells; the eight hospital cells are arranged on separate stands. All the cells are similar, and have each a nominal capacity of 1,000 ampere-hours, the normal rate of discharge being 200 amperes. They are contained in lead boxes, and stand on glass oil insulators upon the longitudinal wooden bearers. The 26 cells in each half nearest the middle wire are connected up by solid copper rods with the regulating switchboard, which stands directly over the main switchboard below. Provision is made for a second battery of similar size, should it be necessary in the future. In the battery circuit there is a registering ampere-hour meter between the outer end of the battery and the switchboard, so connected that its pointer goes backwards on the dial during the charging of the battery and forwards during the discharge. The mechanism is such that the pointer is 10 per cent. slow on the charge; thus if the pointer is always brought back to zero by charging the battery, 10 per cent. more current will be put into the battery than is taken out. This percentage can be altered from time to time as may be judged necessary. The regulating switchboard is connected up to the battery bars on the main switchboard, which are similar to the dynamo bars, and is also connected up to the middle wire. These connections, as well as the special connections for charging the parallel cells and for the hospital cells, are carried in the form of bare copper rods by insulators on the engine-room wall to their respective terminals. The battery has ample capacity to meet the whole of the load of the station from daylight till the evening; thus, during the summer time it can do the lighting during more than half the whole 24 hours.

High-Tension Engine-room.—The high-tension portion of the station consists at present of only two engines and alternators with their switchboard, and the rectifiers for arc lighting with their regulating arrangements and switchboard; but in the immediate future this plant will be considerably extended. Each of the alternators is driven direct by a Willans three-crank engine of 150 i.h.p. on the same bedplate. The alternators are of the "Portsmouth" type, with some modifications necessary owing to their increased speed of 450 revolutions per minute. Their armatures are stationary, and are of great strength; the core, consisting of sheet-iron segments, is solidly bolted into the framing of the machine, with the coils threaded through holes in the sheet iron, well insulated, and completely enclosed in brass boxes. The field magnets revolve, and consist of two heavy cast-steel discs, having on their circumference claws projecting sideways alternately over the field winding, which is between the discs and is well protected from injury. The exciting current is taken from the low-tension switchboard at 230 volts, and is only a few amperes. The alternators work at an E.M.F. of between 2,000 and 2,200 volts with a frequency of 52½ complete alternations per second. The main leads from the alternators, which are concentric, as well as the leads for the exciting current, are taken to the switchboard in chases similar to those in the low-tension engine-room. The arrangement of steam, exhaust, and drain pipes is similar to that already described for the low-tension engine-room.

Switchboard.—The switchboard stands on the switch gallery, and is built up of slabs of slate, forming shelves projecting from the west wall of the engine-room, and divided up into compartments for each alternator and circuit by slate partitions. The outer pole of each circuit and each alternator is connected to an earth-plate at the station, the whole of the rest of the system being insulated from earth. Owing to this arrangement all the switching can be done on the inner pole, which renders the switchboard and its manipulation very simple. The inner pole of each alternator and each circuit is connected to two similar switches through ampere-meters and fuses, and can by these switches be connected to either or both of two omnibus bars at the top of the switchboard. In this way any alternator and any circuit can be connected, and the system can be worked at two different E.M.F.'s if necessary. The primary object of this arrangement, however, is to enable a machine to be thrown into circuit rapidly by running the machine up to full volts on one omnibus bar and changing circuits over from the other omnibus bar on which the other machine is running without having to synchronise the second machine. The two omnibus bars can then be synchronised, the alternator and circuits changed over at leisure, and all the circuits and alternators run in parallel. In the outer circuit of each alternator is connected a registering watt-hour meter for measuring its output. Voltmeters are connected between both of the inner omnibus bars and the outer omnibus bar, and duplicate synchronising transformers with lamps and switches are provided between the two inner omnibus bars. In the exciting circuits are ampere-meters and regulating resistances, the switches of which are placed opposite the switches and ampere-meters of their respective machines. At present the switchboard is arranged for only two alternators and two circuits, but it can be readily extended when required, the gear for new circuits extending in one direction, and that for new alternators in the other. The two circuits are at present connected only to the rectifiers for arc lighting.

Rectifiers.—Opposite to the alternators, and standing on the same foundation block, are placed the Ferranti rectifiers for the series arc lighting. These are three in number—one for each of the two circuits, and one to spare. They each consist of a self-regulating transformer, of which the primary winding is connected to the omnibus bars of the high-tension switchboard, and the secondary winding is connected through a commutator and distributing switchboard to the arc lamps. One winding is hung

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on knife-edges in a frame, and is capable of movement nearer to and further from the other; this automatically keeps the current in the secondary winding constant at 12 amperes, varying the E.M.F. to suit the number of lamps in circuit. The current from the secondary winding of the transformer is then changed, by a commutator driven by a synchronous motor, from an alternating current to a uni-directional pulsating current, which is distributed to the lamps. A small distributing switchboard is placed close to the rectifiers, by means of which any rectifier can be put on to either of the high-tension omnibus bars, and either circuit of arc lamps can be put on to any rectifier, and provision is made on this switchboard for extending the number of arc lamp circuits.

Schedule of Machinery and Plant in the Station.—In the boiler-house, six boilers of 10ft. 3in. mean diameter and 12ft. length, each estimated to evaporate actually 10,000lb. of water per hour; all fitted with superheaters and mechanical stokers; contractor, Mr. G. Sinclair, Leith. One duplex steam feed-pump. Two electrically-driven feed-pumps.

In the engine-room the low-tension plant comprises eight Siemens dynamos; two have each an output of 450 amperes at 135 volts; two of 220 at 275; two of 600 at 260; and two of 865 amperes at 260 volts. The contractors for the engines, dynamos, steam and exhaust piping, feed-pumps, heaters, etc., were Messrs. Siemens Bros. and Co., who also supplied the switchboard and all connections.

The high-tension plant in the engine-room consists of two alternators, each having an output of 40 amperes at 2,100 volts; a high-tension switchboard; and three rectifiers for arc lighting, with switchboard. The contractors for the whole were Messrs. S. Z. de Ferranti.

In the battery-room, 140 Crompton-Howell 31-plate cells, for which the contractors were the Crompton-Howell Electrical Power Storage Company.

Mains.

In the three-wire system of distribution for the northern and central districts, the E.M.F. between the two outer conductors, positive and negative, is 230 volts, while that between the middle wire and the positive or negative is 115 volts. The latter is the E.M.F. of the lamps on the consumers' premises, no trouble being now experienced in obtaining incandescent lamps to work at this E.M.F., or even higher. Distributing mains are laid throughout the streets marked by red lines in the map; all three wires are laid in those streets where the demand for current is large. In the other streets the positive and middle wires are laid on one side of the street, the negative and middle on the other, and a spare way is left on each side for a third conductor, should the demand require it. The distributing mains are all in parallel, and are connected up throughout the system; rings are completed wherever possible, so as to ensure equality of pressure, and to admit of disconnections being made without interrupting the supply.

Feeders.—The feeders from the station, which are marked by blue lines in the map, are connected to the distributing mains at 16 points. They consist of two conductors only, the positive and negative; the middle wire is inter-connected throughout as much as possible, and is brought back from three districts on the system. The cables are put in parallel at the station, and one connection only is made to the switchboard. The positive and negative sides respectively of all the feeders are put in parallel at the switchboard, but any feeder or feeders can be put on a separate machine if required.

Balancing.—As far as possible, consumers in each street and district are balanced against one another by connecting them alternately between positive and middle wires and between negative and middle wires; large consumers have all three wires taken into their premises, and their lights balanced against one another in a similar manner. But however carefully this balancing is done, it is impossible to get a really accurate balance; the "out of balance" current varies from hour to hour and even from minute to minute, and is different on different days of the week. The amount out of balance is compensated for at the station by means of the balancing machines, one of which can be put on either side of the system; the balancing during the light load is done from the battery alone. Light wires, forming potential leads or pilot wires, are brought back from all three conductors at each feeding point, and are connected to the feeder voltmeters on the switchboard, so that the pressure at the feeding points at any part of the system is directly known at the station, and the necessary regulation made for keeping the E.M.F. constant. The distributing mains are brought back to the station, but are used only for the supply of light and power there; no regulation is done on the mains anywhere, except to the feeding points.

High Tension.—No high-tension feeders or distributing mains have yet been laid. They will be laid as concentric cables in ring circuits, and banked transformers in small sub-stations will be used wherever advisable, while houses in districts where the lighting is scattered will be served by isolated transformers. The concentric cables will be pulled into Doulton stoneware casings under the footways, and into cast-iron pipes under the roadways. The casings have already been laid in those streets which have been opened up for the low-tension mains, and the work of laying the high-tension mains in the southern and eastern districts is now being proceeded with.

(To be continued.)

Discussion.

The **President**, in opening the meeting for discussion, referred to the fact that Mr. E. W. Monkhouse, the Edinburgh electrical engineer, was present, and would be able to answer questions as to the working of the station.

Mr. W. H. Patchell, the engineer to the Charing Cross and Strand Electricity Supply Corporation, doubted the advantage of using alternate-current machinery in the station for the supply of the scattered district, and advocated rather the use of high-tension continuous-current transformers. He approved of the statement that the ordinary feed-pump was a steam eater, but would like to hear if the electric pump was cheaper in practice. He believed that it was easy to prove on paper a balance of advantages for either system. He stated that he had been experimenting on superheating, but had not succeeded in getting the superheat beyond the stop-valve. He had obtained 10 per cent. superheating, but the whole of this was absorbed in the steam pipes.

Mr. W. Geipel regretted that the author had not given the cost of the plant laid down at Edinburgh. He most strongly approved of superheating the steam, but asked if the position of the superheaters had been found satisfactory. When the boilers were being forced the temperature of the gases passing over the superheaters would, he thought, be sufficiently high, but he doubted if that would be the case at light loads, when, owing to the low velocity of the steam in the pipes, the superheat was specially needed. He approved of covering the flanges of the steam-pipes, as he estimated that every square foot of surface exposed required the consumption of half a ton of coal per annum if the steam pressure was on continuously. He also asked if anyone present had observed deleterious effects from the use of steel flanges on copper pipes owing to electrolytic action. As regarded the system of supply, Mr. Geipel could not see the advantage of mixing up the various types of machines and so multiplying the number of units and spare set. He would have preferred to use the alternating-current system only, and to instal larger units. After referring to advantages which would accrue by adopting some standard frequency with alternating currents in England, he concluded by criticising the use of omnibus bars in the low-tension system.

Mr. S. Baynes did not agree with Mr. Geipel as to the troubles that would occur in the future if omnibus bars were used. At Bradford it was assumed that such would be the case, and rheostats had been provided in the feeders to correct for the difference of voltage. He had found, however, that as the load on the station had increased no such difficulties occurred, and that a number of feeders could be selected which could be worked satisfactorily when grouped on omnibus bars. The difficulty of regulation would be still further overcome if higher-voltage lamps were employed, as he hoped to do at St. Pancras.

Mr. W. H. Patchell, in reply to Mr. Geipel's query about the electrolytic action when steel flanges were used on copper pipes, said that he had found no such action when the feed water used was hard. On the other hand, with South London water, which had a somewhat alkaline reaction, he had experienced much trouble, and the corrosion was always at the bottom of the pipe, where the water would naturally assist the electrolytic action. In fact, one set of steam-pipes were condemned for that cause.

Mr. E. W. Monkhouse placed a most interesting diagram before the meeting, which showed the growth of the demand since the station was opened and the details as to cost. The equivalent number of lamps connected had increased in that time from 2,500 up to 34,000. The cost per unit generated worked out each week had naturally fluctuated with the lighting hours. The maximum value was 1·78d., and occurred in the eighth week after opening. The lowest cost per unit was ·886d., and the average now stood at about ·9d. For the past week the detailed cost were as follow: Station charges, ·127d.; wages, ·313d.; fuel, ·319d.; stores, ·026d.; water, ·034d.; repairs, carbons, etc., ·088d., making a total of ·907d. The units sold were 90·8 per cent of the units generated, so that the cost per unit sold was only a penny, which was not bad for a station only six months at work. He had observed that the coal required to keep a boiler banked was, in the summer, 3cwt. The steam-pipes did not vibrate. The low-tension mains now laid consisted of 22 miles of distributing network and 2½ miles of feeders. About 8 miles of high-tension mains were now being constructed.

Mr. H. R. J. Burstall, in reply, said that the question of the system to be used at Edinburgh had not been decided by guesswork, but that the details of six different systems of supply had been carefully worked out and compared. He did not consider that constant-current transformers were suitable for a scattered district, where it did not pay to lay down low-tension distributing mains, and the demand in those parts of Edinburgh supplied on the alternating system would not warrant that step for some years. Hence transformers in the consumers' premises would be used. As regarded the general question of direct current and alternating, he held that each town must be considered by itself, and that it was impossible for any engineer to lay down definite rules on the subject. With respect to the electrolytic action in copper steam-pipes with steel flanges, his six years of experience with such work had not shown any defects in the system.

Prof. Kennedy, after passing a vote of thanks to the author of the paper, referred to some trials which he made with the super-

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heaters in September. He obtained 10deg. of superheat, and the temperatures in the flues before and after the superheating were 738deg. and 534deg. respectively. Alterations were suggested by the trials, which he expected to considerably increase the efficiency of the apparatus.

AN EXPERIMENT IN WATERWHEEL GOVERNING.

BY WILLIAM W. HANDY.

It is well known among engineers that waterwheels constitute the most difficult class of prime movers to govern, and also that prime movers require very close regulation when running dynamos.

Now just at this time, when water power is being so largely used for electrical transmission, the need of good governing is more felt than ever before. In an experiment carried out by the author on a turbine plant supplying current for incandescent lighting, very good regulation was obtained by means of a simple electric governor.

The diagram, Fig. 1, shows the principle on which the governor works. Connected to the dynamo, 1, is a shunt coil, 2, and a series coil, 3. These coils are connected to the dynamo in such a way that the action of one opposes

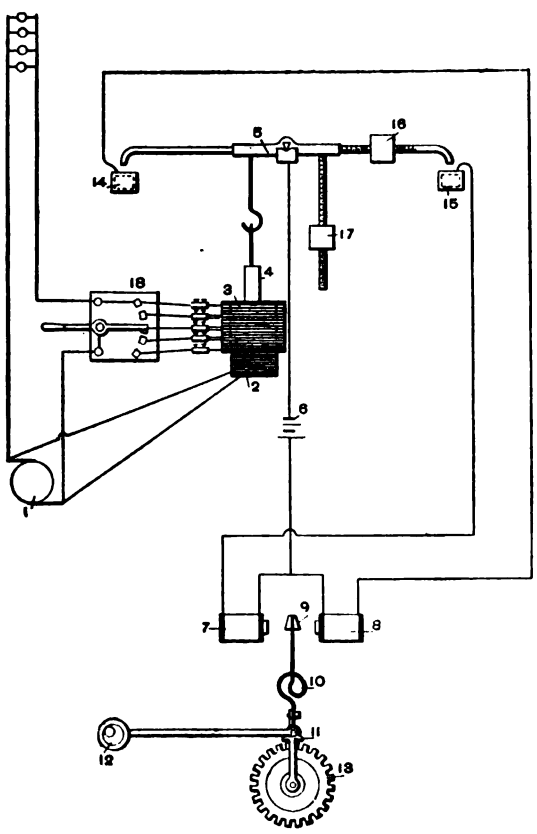

FIG. 1.

that of the other. The coils attract a plunger, 4, which is suspended from a lever, 5; 14 and 15 are mercury-cups into which the ends of the lever may dip. These cups are connected, as shown, to the magnets, 7 and 8; 6 is a storage battery connected, as shown, to the lever and the magnets. It is readily seen if the lever, 5, moves from a central position it closes the circuit through one of the mercury-cups and causes one of the magnets, 7 or 8, to become excited.

These magnets act on an armature, I, which is connected by the spring, 10, to the double pawl, 11. The pawl obtains constant reciprocating motion from the eccentric, 12, which in turn obtains constant motion from the waterwheel. As the armature is attracted by one or other of the magnets the pawl is caused to engage with the ratchet wheel, 13, and turn it in a direction depending on which magnet attracts the armature. The ratchet wheel is connected to the gate shaft of the waterwheel, and as the ratchet wheel turns the gates are opened or closed, thus governing the speed of the waterwheel. When neither of the magnets are excited, and therefore the armature not attracted by either, the pawl is held in a central position by means of a spring, not shown in the diagram, and the ratchet wheel, and, therefore, the gates, remain still.

Now, suppose the dynamo is running at the right voltage with no load on, and consequently with a current through the shunt coil, 2, only, the weights, 16 and 17, being adjusted on the lever, so as to balance the pull of coil 2, just sufficient to keep the lever in a central position. Now, when the full load is thrown on the dynamo, it is desirable in constant-potential distribution to keep the voltage constant at the end of the line, and this is attained by this governor in the following manner: due to the increase of load, and the consequent decrease of speed and voltage, the current through the series coil, 3, will increase, and through the shunt coil, 2, decrease. The pull on the plunger will decrease, and the lever will make contact in cup, 15, magnet, 8, will be excited, the armature, 9, attracted by it, and the pawl will turn at the ratchet wheel, 13, so as to open the gates. This will continue until the speed, and therefore the voltage, has increased sufficient to increase the pull of the shunt coil, 2, and break contact at 15, when the governor will stop working. Now, if the strength of the series coil, 3, has been properly adjusted by means of the switch, 18, contact will not be broken at 15 until the voltage of the dynamo has been increased to the desired amount to overcome the drop on the line, and keep the voltage at the end of it what it was for no load. Now, if the load is decreased it can readily be seen that the lever will make contact at 14, and cause the gates to close, and this will continue until the voltage has decreased sufficient to break contact at 14. The voltage for this load will be found to be the proper value to keep the voltage constant at the end of the line.

The practicability of this governor has been demonstrated, and the curves shown in Fig. 2 give the results of

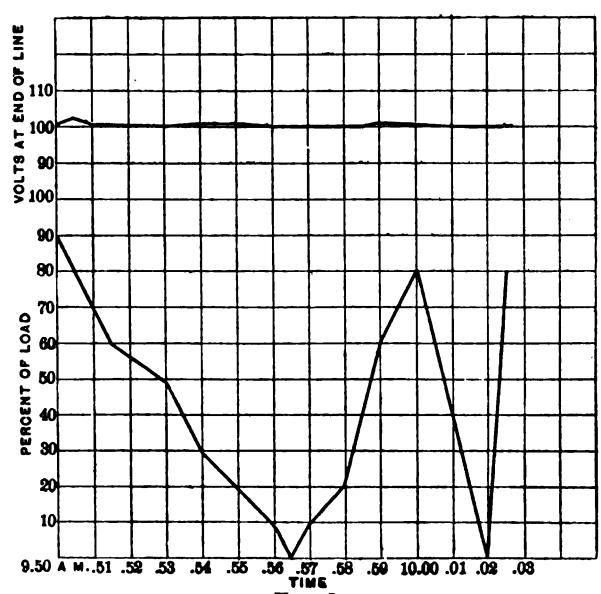

FIG. 2.

a test taken from a small plant on which the governor was working. The dynamo was a continuous-current shunt-wound machine, used for incandescent lighting at 100 volts. The waterwheel was a Burnham turbine, with register gate. The drop on the line was 7 per cent. at full load, and a constant voltage was desired at the end of it. The readings shown by the curves were taken at the end of the line, and show very plainly that under extreme variations of load the voltage was kept practically constant, the difference between the highest and lowest reading on the voltage curve being only two volts.

WHAT, WHEN, AND WHERE.

Institution of Junior Engineers.

November 1, 8 p.m.—At the Westminster Palace Hotel. Presidential address by Archibald Denny, M.I.N.A.

North-East Coast Institution of Engineers and Shipbuilders.

October 25, 7.30 p.m.—First business meeting: Presentation of gold medals for papers read during the eleventh session. Opening remarks by the President. Paper on the "Surface Condensing Plant at the Newcastle and District Company's Electric Works, Forth Banks, Newcastle-on-Tyne," by W. Cross. Discussion.

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EXTENSION.

Most of our central stations are built with a view to extension, yet in some cases when the need of extension has become urgent, there is an apparent indisposition to countenance the extension. Now, a central station is to all intents and purposes a manufactory. True, it does not turn out sheetings, cloth, or steel—it simply turns out energy. However, it will be found that what is true of all other factories and all other businesses is also true of this business. The larger the factory, and the better it is equipped, and the larger the business it does, the better is the resultant manufacture, the cheaper is the work turned out, and the larger are the profits. A baker selling a hundred loaves per diem cannot obtain the same return even by selling at fifty per cent. per loaf profit as can the baker selling ten thousand loaves a day who sells at five per cent. per loaf profit. The capital expenditure per loaf turned out in the first case is out of all proportion to the capital expenditure per loaf turned out in the second case. It is only certain costs that increase proportionately to the work done; other charges decrease very largely with the increase of work. Hence it seems to us that, instead of holding back assent to extension, every authority should eagerly welcome its necessity. Assume a simple case—that twenty thousand pounds have been expended on a central station, designed with a view to extension, and that the apparatus is loaded to its full capacity: it does not mean that the expenditure of another twenty thousand pounds will only double the producing power; the probability is that it will more than treble it, so that the capital expenditure per unit produced will be considerably reduced. It should be seen at once, if what we have suggested is true, that each unit produced after extension has to pay interest on a smaller initial capital, and thus can, if the producer thinks fit, be sold at a lower price to obtain the same return. But further, the cost of clerical work, in fact, all the constant charges, are reduced per unit by the increased business. Hence, from this point of view again, each unit can be sold cheaper if the producer is satisfied with his previous return. Reduction in price assists extension of business, so that the resultant good is found in this direction also. We are not sure that all the municipalities which have embarked upon this work have well-defined aims, but we think, whether for lighting or heating purposes, the death-knell has commenced to ring for gas, so that the ultimate objective of central-station work should be to provide all the artificial light required by the district, and, perhaps, in addition, some of the power and some of the heat. The capital which has been embarked in gas undertakings, even with the above optimistic views, will not necessarily be lost, nor will it necessarily bring in much less return than it does at present. But it is not our province to attempt to prophesy what will become of gas undertakings, but rather to indicate what must take place with regard to electricity. As regards the latter, the simple fact must always be remembered that,

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like all other manufactures, the production upon a comparatively small scale must be more costly than the production on a large scale, and so efforts should be made to extend with all speed. The sooner the extension suffices to supply the light to the whole district, the sooner will production be at its cheapest and the return at its maximum. Another phase of this question about which there seems to be much difference of opinion is, whether the attempt should be made so to produce and sell as to show a good large amount annually to be placed to the benefit of the rates, or whether the full value of every extension and improvement should be given to the purchaser and no attempt made to show large profits. We cannot attempt to determine this problem—it is in our view indeterminate. There are those who argue that indirect taxation is better than direct, and point out that with the former a man never knows what he pays, nor does he feels so keenly the incidence of taxation as he does when paying direct. There is much to be said on both sides, but with regard to central stations they must, to be successful, earn enough to keep them thoroughly efficient and to pay the annual instalments of capital. If they have something in addition to this, it goes to benefit the rates. Our argument holds good in either case, that the larger the station the more economical it is on all sides, and the greater the benefit it confers upon purchasers and ratepayers.

MAGNETISATION AND CHANGE IN LENGTH OF IRON WIRES.

Dr. L. J. More, of Johns Hopkins University, communicates to the *Philosophical Magazine* some most interesting experiments on the alteration in length of iron wires when magnetised. He first summarises the results of previous experimenters on the same subject as follows:

Soft iron elongates when magnetised. The elongation attains a maximum, and then diminishes with increasing strength of field until a state is reached when the rod returns to its original length. Further increase of field causes the rod to contract. There is no minimum length, the rod approaching asymptotically a limiting value. For a given strength of field, both hardening and annealing diminish the elongation and increase the contraction shown by the rod before it was subjected to these operations (Bidwell). Tension also diminishes the elongation and increases the contraction of the rod. For a sufficiently great tension no elongation occurs, the rod contracting upon the application of the smallest magnetising forces. For a given length, the effects both of elongation and of contraction are greater for thin than for thick rods (Bidwell). S. J. Lochner comes to the conclusion from his own experiments that the converse is true—that thick bars give greater expansion than thin ones.

Very little reliance can be put in these last experiments, and the dependence of the change of length upon the ratio of the length to the diameter cannot be inferred from them. Bidwell used three rods, 10 centimetres long and 2·65, 3·65, and 6·25 millimetres in diameter, and assumed them to be of iron of similar composition. It is well known that different specimens of iron, apparently similar in structure, give results that vary 25 per cent. and more. So that the small variations in the change of length noted by him cannot safely be said to be due to the differences in their diameters, especially as he made no determination of the permeability. Lochner avoided this error by testing an iron rod, and then, after having cut off a portion, testing it again. He, however, took no precautions to have the field uniform. His solenoid was nearly four times as long as the shortest rod used, and the ratio of the diameter to the length of the rod was only 1 to 32. Besides the uncertainties introduced by such a poor arrangement for a uniform field, great errors would be produced by the strong poles created at the ends of the rod.

The author then proceeds to describe his apparatus, which was so constructed that the modulus of elasticity could be conveniently obtained on it. The wire to be tested was suspended from a tall tripod standing on a stone slab. A hole was cut in the slab so that the wire could be passed through it and the free end permitted to almost reach the floor of the room. A hollow brass cylinder, 1·6cm. in diameter and about 68cm. long, was screwed to the wire at a point just above the stone slab. A loosely-fitting cork plug in the upper open end of this cylinder serves to keep the wire in the axis. The wire to be experimented on thus was contained in the tube, and the elongation was measured by a system of levers and mirrors attached to the tube and wire respectively. The most important dimensions were:

Length of wire stretched	69·9cm.
Ratio of lever arms	119/4·65
Distance between needle-points	2·3mm.
Distance to telescope and scale	1,660·0mm.

The multiplying power of the apparatus was therefore:

$$\frac{119}{4\cdot65}\times\frac{1,660}{2\cdot3}\times 2 = 36941.$$

And as the scale was graduated to millimetres, one scale division represented an actual change of length of $2\cdot7\times10^{-5}$ millimetres.

The coil to magnetise the wire stood on the stone slab, and was long enough to reach just below the lever arm, so that the part of the wire experimented on was in a practically uniform field. The principal dimensions of this coil were as follows:

Length of coil	83·7cm.
External diameter	6·3cm.
Internal diameter	3·6cm.
Number of wire	18.
Number of turns	3,045.
Number of layers	7.
Number of turns per centimetre	36·4.
Resistance of coil	10 53 ohms.
Strength of field per ampere	45·74 C.G.S.
Maximum field	260·00 C.G.S.

The core of this coil was made of two co-axial brass cylinders, fastened together by the end plates of the coil. The space between these two cylinders was filled with water, which proved to be an excellent way of retarding the heat effects produced by the current.

With the apparatus the author proceeded to experiment with wire 1mm. diameter under three conditions—*i.e.*, normal condition, hardened wire, and wire under stress. He corrects the results obtained from the contraction due to the $B^2/8\pi$ force. This contraction is obtained from the formula $\frac{\delta l}{l}\times10^7=\frac{B^2/8\pi}{M}$, where M is the modulus of elasticity of the sample.

The following is a summary of the results obtained by this investigation:

1. A relation has been obtained between the elongation due to magnetisation and the intensity of magnetisation of soft iron. When the elongation has been corrected for the contraction caused by the $B^2/8\pi$ force, the relation may be expressed thus: A rod of iron elongates slowly until an intensity of about 800 is reached. After that point the rod elongates more rapidly and attains a maximum value of about 60×10^{-7} part of its length at an intensity of 1,200. With greater intensities the elongation diminishes, the curve being approximately a nearly vertical straight line

2. Hardening the wire diminishes the corrected elongation, and the wire attains its maximum length in a less intense field.

3. It has been shown that when the wire is stretched the change in elasticity due to the magnetisation produces an

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important effect. Neglecting this correction, the effects of stretching are similar to those caused by hardening the wire.

A SINGLE-PHASE POWER TRANSMISSION PLANT.

It is not well known that the General Electric Company of America has exploited a synchronous system of electric power transmission, but the interesting plant installed by that concern for the Walla Walla (Wash.) Gas and Electric Company, in the spring of 1893, demonstrates this fact.

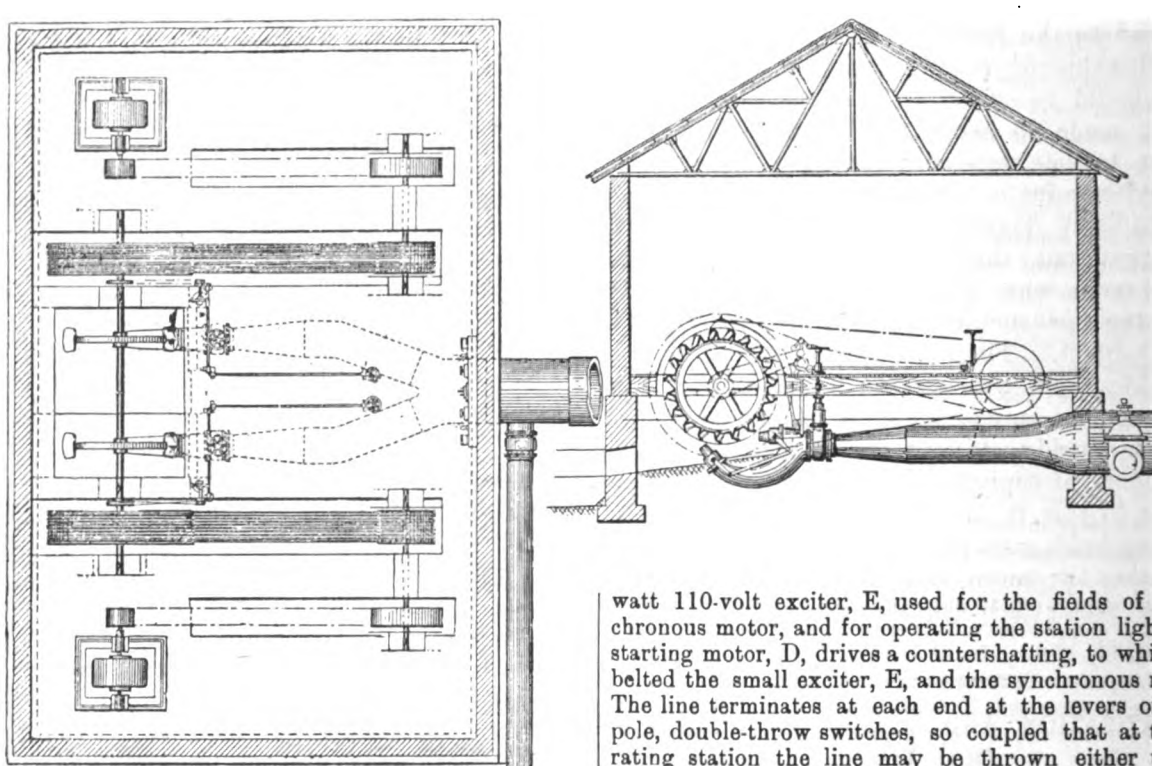

FIG. 1.—Plan of Generating Station, Walla Walla Transmission.

The features of the installation are so distinctive and the plant being placed at a time when the company named was believed to be strenuously endeavouring to devise a system of power transmission that would, at least, be abreast of other manufacturers, led to the conclusion that the plant in question formed a stepping stone in the development of the art. At that time single-phase transmission was in successful operation at Telluride, Col., using the synchronous system of the Westinghouse Electric and Manufacturing Company, and a similar plant was about to be installed by the Standard Consolidated Mining Company, of Bodie, Cal., but polyphase transmission was practically unknown in commercial circles. The Walla Walla Gas and Electric Company felt it to be imperative that the water power of Mill Creek should be utilised to operate its electric light and power plant, and the installation described was placed. That it operates satisfactorily is unquestionable, but it is improbable that similar conditions would now be satisfied by the installation of a plant of its character.

The generating station, which is situated on Mill Creek, a distance of four miles from the city receiving station, is operated by water power, the water being brought in a wood stave pipe, 48in. in diameter, and having a total length of 6,000ft. The effective head is 66ft., and the wood pipe terminates in a sheet-iron Y pipe, supplying two Pelton wheels that are 6½ft. in diameter, supplied with double nozzles and run at 100 revolutions per minute. The capacity of the wheels are 175 h.p. each, which is transmitted to the main countershaft by means of two endless compound rope drives, all as shown in the accompanying outline cut of the plant, Fig. 1. The dynamos are belt-driven from the countershaft, and the plant was laid out for double its present capacity. The synchronous motor at the city station operates power and lighting generators.

The generating station contains one 100-kilowatt single phase 2,000-volt Thomson-Houston generator, having a frequency of 8,000 and being composite wound, together with one 15-kilowatt 500-volt exciter, which from the manner of its use also becomes a starting generator. These machines are shown in Fig. 2 as A and B respectively. The line consists of a single circuit of No. 0 B. & S. wire, leading direct from the generating station to the city plant of the company, a distance of about four miles. This receiving plant contains one 100-kilowatt 2,000-volt synchronous motor, designated as C, one 7½-h.p. direct-current bipolar starting motor, shown as D, and a small 1½-kilowatt 110-volt exciter, E, used for the fields of the synchronous motor, and for operating the station lights. The starting motor, D, drives a countershafting, to which is also belted the small exciter, E, and the synchronous motor, C. The line terminates at each end at the levers of double-pole, double-throw switches, so coupled that at the generating station the line may be thrown either upon the 500-volt exciter or the 2,000-volt alternator, so that at the receiving station the line may be thrown upon the bipolar starting motor, or upon the 2,000-volt synchronous motor. The switchboards at the two stations contain all the forms of instruments usual for the purposes of the currents handled, the entire equipment being complete in every detail.

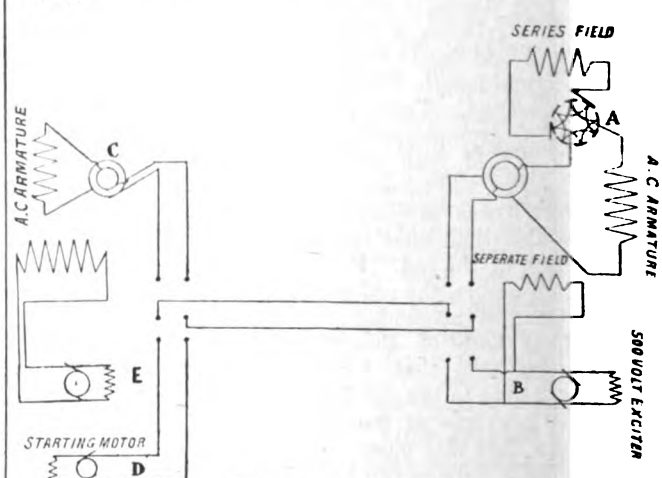

FIG. 2.—Circuit Diagram of the Walla Walla Transmission.

The method of putting the plant in operation is as follows: The generating plant is brought up to speed and the rheostat in the fields of the 500-volt exciter is cut out for maximum voltage. The fields of the generator are excited therefrom, no attention whatever being paid to the voltage of the alternator. The double-pole, double-throw switch is then brought down upon the jaws forming the terminals of the 500-volt exciter, which throws its potential upon the line. The attendant at the generating station has in the meantime telephoned to the attendant at the receiving station that he has started

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up, whereupon the latter throws the line current upon the small starting motor by bringing down the switch upon its terminals, as shown in the diagram. The starting motor then brings the synchronous motor and its exciter up to speed through countershafting. The armature of the alternator runs idle in dead fields, but the exciter is brought up to voltage and connected with its pilot lamp to avoid error. When the synchronous motor has been brought up to proper speed, the station attendant telephones to the power plant to stand by the main switch, whereupon the motor attendant opens up the main switch and quickly throws in the station transformer operating the pilot lamp and voltmeter on to the line through a primary switch, and then waits for the appearance of the 2,000-volt alternating current before closing the main switch that throws the line to the synchronous motor.

In the meantime the attendant at the generating station, who, in compliance with instructions from the motor-station attendant, has been standing by the main switch, quickly throws the main switch from the 500-volt contact to the 2,000-volt contact as soon as he sees the needle of the current indicator drop back to zero, which obviously is positive information to him that the attendant at the receiving station has cut the starting motor off the line. Thereupon the attendant at the motor station, who has been watching the pilot lamp operated from the station transformer, throws the line upon the synchronous motor with one hand as soon as the lamp comes up to candle-power, and immediately closes the field circuit of the alternator with the other hand. The motor at once comes in step, the starting motor is then shut down by throwing the clutch on its countershaft pulley, and the plant does its work with perfect satisfaction.

The method of starting was designed by Mr. W. A. Burkholder, then district engineer for the Pacific North-West district of the General Electric Company, and who is now general superintendent of the Portland (Ore.) General Electric Company. Provided the speed of the synchronous motor is higher than that of the generator, the motor will invariably synchronise with the generator, and has never given any trouble whatever.

THE JANDUS ARC LAMP.

Yesterday (Thursday) we paid a visit, at the invitation of Messrs. Drake and Gorham, to Messrs. Johnson and Phillips's works at Old Charlton, in order to inspect the arc lamp invented by Mr. Jandus (of the Manhattan Company, New York), who, we understand, has been awarded the Franklin medal for his device. It is stated that the success of this lamp in America has "exceeded all expectations," inasmuch as it is claimed that the lamp burns for 200 hours with a single pair of carbons. The additional life is obtained by enclosing the carbon rods in a small globe of special construction, which is again enclosed in a large globe, hermetically sealed at the top.

On starting the light the available oxygen is at once consumed, and the inner globe is filled with an inert gas which does not promote combustion. The expansion of the gases due to heat expels through a special valve most of the oxygen from the outer globe, which in its turn soon becomes charged with a rarefied gas. This system is not new, but Mr. Jandus has apparently overcome the defect of previous efforts in this direction—the blackening of the globe. The conditions of the arc are found to be such that the carbons can be separated to a greater extent than has hitherto been found possible without flaring. The voltage across the arc is from 75 to 80, with a five-ampere current. The light in the lamps we saw running was steady enough, but doubt was expressed by one or two of the company present as to the candle-power of the lamp compared with the ordinary arc lamp, and we understand that tests as to the candle-power per watt of the lamp are to be independently made by a high authority. The mechanism, which is partly on the dashpot principle, with a magnet suspended inside the coil, is fairly simple. The Jandus Arc Lamp Company, of Manchester, have appointed Messrs. Drake and Gorham, of 66, Victoria-street, Westminster, to be their sole agents for the lamp. Mr. Barton, the managing director of the company, stated at Charlton that the Edison Company in the United States allow consumers using the Jandus arc lamp a rebate of 10 per cent. on account of the saving in trimming.

PLYMOUTH.

REPORT TO THE ELECTRIC LIGHTING COMMITTEE OF THE CORPORATION BY DR. J. A. FLEMING, F.R.S.

(Concluded from page 457.)

CAPITAL OUTLAY.

Until I am in possession of more information than is at present before me as to the location of any arc lighting which may be undertaken, the figures for capital outlay cannot be given in full detail. As before observed, the capacity of any electric station for the supply is properly measured in units called a kilowatt, and this is approximately equal to 1½ h.p. Experience shows that a larger number of lamps than those equivalent to the full capacity of the dynamos can always be connected to the circuits because all the lamps are not in use simultaneously. The ratio of the maximum number of lamps in use to the total number connected will vary according to the nature of the users. In some of the larger town stations not more than 50 per cent. of the lamps connected are ever simultaneously in use. Experience, however, shows that if the lighting consists largely of shop-lighting the difference between maximum number of lamps in use and total number connected is not nearly so great, and will probably be about 75 or 80 per cent. From data obtained from other places I am led to the conclusion that if provision is made in Plymouth for the simultaneous use of 7,500 8-c.p. lamps, about 10,000 such lamps could be connected to the supply circuits.

In addition to this, we have, however, to make allowance for reserve plant in case of accidents, and for a station of the above capacity, and having dynamos units of the size suggested, there should be reserve plant of about 30 per cent.—that is to say, if we provide generating plant of 400 kilowatts capacity, allowing 300 kilowatts for the full working power and 100 kilowatts for the reserve, we shall be able to supply current simultaneously for 7 500 8-c.p. lamps, and to connect about 10,000 such lamps, or perhaps more, to the system. My recommendation therefore is that the station should contain at first five engine-alternator plants, two units being of 50-kilowatt capacity and three of 100-kilowatt capacity. This will provide for an effective output of 300 kilowatts, with 100 kilowatts reserve, the alternators all being capable of being worked in parallel together.

The capital outlay required to establish any station is best estimated in cost per kilowatt. The appended table of statistics has been extracted from valuable information collected by the electrical paper *Lightning*, from Board of Trade returns, and show the capital outlay which has been made upon certain continuous and alternating-current stations already at work. It will be seen that these numbers vary over rather wide limits. In the case of those stations established by companies, there are probably reasons for this which do not appear upon the surface, but if we take the corporation stations established on the low-tension system and those established on the high tension system, it will be seen that the average cost of the seven low-tension stations tabulated is £94 per kilowatt, and the average cost of the six high-tension stations in the appended tables is £93. The average, excepting Burton, which for some reasons is abnormally high, is £84.

A deduction from a larger number of instances would confirm the view which is certainly the correct one—namely, that the average cost per kilowatt of establishing a high-tension station is somewhat less than the average cost of establishing a low-tension station of equal powers.

If we take Portsmouth as a typical instance of a well-designed high tension station, the capital outlay there has been £71 per kilowatt It will also be seen from these tables that the revenue per lamp varies very much in different places, in some being abnormally low, and in others approximating to that which may be considered a fairly average price—viz., 8s. to 10s. per 8-c.p. lamp installed per annum. If at the outset the electric supply from the station is given only from dusk to dawn, and not continuously during the 24 hours, then the ratio of working costs to revenue can be kept down to a figure which will not be far from 50 to 60 per cent. Hence, considering the establishment of an alternating-current station having a total capacity of 400 kilowatts, the total capital outlay at £80 per kilowatt will be about £32,000. To this £32,000 I add another £3,000 to cover contingencies, the uncertain factor as to the amount of constructive work to be done in preparing the ground and waterside for the station, and the architect's and engineer's commissions, making in all £35.000. Hence, it may be considered, that for a well-designed alternating-current supply station, having a total capacity, say, of 400 kilowatts, and a lamp connection of 10,000 8-candle lamps, and spare plant and effective working capacity of 300 kilowatts, the probable revenue would be about £5,000 a year, and the capital outlay about £35,000. On an annual output of 200,000 units it can be shown that the whole operating cost can be brought within £3,500, and thus leave £1,500 to pay the share of sinking fund and interest. As far, therefore, as incandescent lighting is

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STATISTICS OF SOME ELECTRIC SUPPLY STATIONS AT THE END OF 1894, ESTABLISHED BY COMPANIES IN THE PROVINCES.

Low Tension.

Company.	Total capital expended	Capacity of dynamos in kilowatts.	Capital outlay per kilowatt installed.	Total cost per unit sold in pence.	Average price per unit in pence.	Units sold per lamp	Revenue per lamp	Ratio of costs to revenue in per cent.
	£		£				s. d	
Hove	48,828	308	159	5·42	7 83	9 27	6 1	67 68
Liverpool	252,152	2,200	115	2 46	6 82	20·48	11 7	34·61
Preston	64 081	602	106	3 95	5·02	21 23	8 10	78·20
Northampton	19 932	200	100	4·42	7·13	12 26	7 3	58 94
Southampton	17,395	200	87	4 41	6 78	21·72	12 5	63 20

High Tension.

Oxford	62,538	240	261	3·72	6 04*	18 14*	9 1	58·65
Eastbourne	44 137	310	142	4·22	8·45	13·30	9 4	46 03
Bournemouth	50,708	500	101	5·91	7·44	13·21	8 2	75 81
Leeds	64 118	700	92	3·11	5 68	21 47	10 1	52·11
Exeter	21,118	231	91	3·29†	4·21†	23·47†	8 11	76·00†
Scarborough	25 987	300	87	4 83	6 22	11 50	5 11	75·50
Newcastle-on-Tyne	51,641	600	86	2 80	4 15	18·53	6 5	61 53
Sheffield	52,187	615	85	3 80	5 78	17 80	8 7	64 59
Cambridge	31,503	450	70	5 27	6·75	10 98	5 2	72 51

STATISTICS OF SOME ELECTRIC SUPPLY STATIONS AT THE END OF 1894, ESTABLISHED BY MUNICIPAL AUTHORITIES IN THE PROVINCES.

Low Tension.

Brighton	119 382	910	131	2 30	6·12	22·45	11 6	36·20
Aberdeen	23,558	190	124	3·13	6·56	12 52‡	6 10‡	46 26
Burnley	20,727	204	102	3 13	5·63	15 77	7 4	53·94
St. Pancras	109,932	1,100	100	3 03	5·32	21 71	9 7	55 74
Hull	39 032	480	81	2 86	6 73	12 56	7 0	39 88
Bradford	64 186	973	66	2 54	4 80	14 64	7 2	51 68
Lancaster	15 267	288	53	6 60	6·04	8·28§	4 2	95·62

High Tension.

Burton	27,008	198	136	10·50	6 00	7·18	3 7	166 46
Huddersfield	46 041	500	92	3·28	4 84	12 46	5 0	60 87
Bristol	82 186	930	88	4 38	4·70	26 84	10 5	91 11
Taunton	14 877	170	88	4·47	4 96	20 28	8 11	88 67
Dublin	41,666	500	83	4·09	4 88	—	—	79·31
Portsmouth	56,050	786	71	2·28	4 50	15 27‖	5 8	50·16

* These figures include public and private lighting. † Business done by contract not by meter data therefore is unreliable. ‡ For 10 months, March 1 to December 31, 1894 § For 8½ months, April 18 to December 31, 1894 ‖ For 6½ months to December 31, 1894, supply not constant.

concerned, the general scheme for electric lighting of Plymouth should, in my opinion, comprise a station having an ultimate capacity of 30,000 8-c p. lamps, but the initial scheme should only contemplate the actual erection of about one-third of this station.

There is good ground for stating that if started on these lines, and assuming that about 5,000 lamps can be connected soon after the commencement of supply, the result would be that at the end of the first year of working all the operating expenses would be paid, and that by the end of the second year a contribution would be made towards the reduction of the debt and the interest on the same, and that from and after the time when the lamp connection reached 10,000 8-c.p. lamps, it might be fully expected that a profit would be made over and above the amount required for working costs and interest.

The above estimate does not include the arc lighting plant. The general recommendation I make for this portion of the work is that arc lighting plant should be established at first for about 90 arc lamps with proper reserve plant. This will require four direct-driven arc lighting machines—three for use and one spare plant—these being either dynamos or equivalent plant in rectifiers. Separate engines will have to be provided for these arc light dynamos if adopted, but the steam can be taken from the same boilers which supply the steam for the incandescent lighting dynamos. If the rectifiers are employed no separate engines are required, and subject to the consideration of tenders, the expe rience at Portsmouth and other places warrant me in believing that there are strong reasons in favour of employing the rectifiers for the arc lighting plant.

My conclusions therefore on the subject of electric lighting in Plymouth are as follow: (1) That there is every reason to believe that if a municipal electric lighting station is established in Plymouth for the supply of current for public and private lighting, the growth of a demand for the light would be as progressive as in other towns of similar size and character. (2) My opinion is that this station should be on the alternating-current system with transformer sub-stations, and that public street arc lighting should form part of the scheme, the arc lights being operated by continuous currents either generated by separate machines or by the conversion of the alternating current. (3) The station should be planned for an ultimate demand of about 30,000 8-c p. incandescent lamps and 200 arc lamps, but the initial outlay should only comprise plant for 7,500 lamps, and that part of the building necessary for the plant for 10,000 lamps. The chimney stack should be put in for its full capacity at once. (4) The immediate provision for the arc lighting should include plant for about 90 or 100 300-watt street arc lamps, which would be equivalent to lighting about three miles of streets. These lamps to be placed in the principal streets and on the Hoe. (5) The capital outlay for that part of the scheme concerned with the private or incandescent lighting would involve a probable outlay of £35,000. The uncertain factor at the present moment in this estimate is the amount of constructive work which would be necessary to be done in order to plant the station on the Cattewater site in such a position as to be able to utilise water for condensation purposes at all states of the tide. Subject to the opinion of your borough surveyor, I think that this would involve the construction of a quay or wharf, on which part of the station would have to be placed. This part of the outlay would be controlled by the special consideration as to the nature of the foundations to be obtained, the amount of pile driving necessary, if any, and hydraulic work generally. The advantages to be obtained by continuous condensation, especially at the times of light load, are, however, very great, and I should strongly desire to see the station placed in a position to utilise the tidal water for surface condensation at all states of the tide, without having to pump it to a considerable distance. If station buildings were constructed for the first suggested section of the plant having a length of 120ft., width 60ft., and mean height 30ft., a plain but substantial building, constructed with stone found on the site, and taking the average cost at about 6d. a foot, ought to be erected for £5,000. The chimney stack and foundations for the same should be covered by an additional £1,000. The cost of such a building ought therefore not to exceed £6,000 to £7,000. The items estimated approximately would be as follow:

Foundations, buildings, and shaft	£7,000
Engines, boilers, steam-piping, pumps, condensers, dynamos, and switchboards	15,000
Overhead traveller and fittings generally of the station	1,500
Mains and transformers	7,500
Meters and other accessories	1,500
Erection, incidentals, labour, and professional charges	2,100
The total amounting to	£35,000

For this would be obtained an electric station having an effective output of 300 kilowatts, and an installed plant equal to 400 kilowatts in power and capable of maintaining 10 000 8-c.p. lamps in action, placed in and above the centre of the town, with a sufficient reserve plant for all emergencies.

(6.) The provisions for the arc lighting plant, in addition to this, would have to include the arc lamps, cast-iron street arc lamp standards, underground conductors, and arc light machines and engines. The steam would be taken from the steam boilers that supply the incandescent plant. My estimate for the above arc

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lighting plant is approximately £6,600 for a plant capacity of 90 arc lamps of 300-watt power. These arc lamps would cost to maintain from £15 to £17 per annum, and would entirely replace the gas lamps over a street run of at least 12,000ft. and probably over about three miles, whilst the average illumination of the street surface would be increased in some places tenfold. It is difficult to provide a closer estimate of the capital outlay for the arc lighting until the location of the arc lamps is known and the precise length of the underground conductors necessary.

(7) The income to be derived from such a capital outlay may reasonably be expected to be as follows: If the consumption of current for the incandescent lights proves to be similar to that in other towns of like character, it will be seen by reference to the tables in the foregoing part of the report that with the exception of a few towns in which the revenue per lamp is abnormally low, a fair estimate of the earning power of the 8-c.p. lamp is from 9s. to 10s. per annum, and that, therefore, the income from the 10,000 incandescent lamps would, in all probability, amount to £5,000 per annum. The whole of the generating expenses, not including interest on capital, ought to be covered by £3,500 when the station reaches it full output of 10,000 lamps, hence leaving £1 500 as a contribution towards the interest on loan and sinking fund.

(8) As far as regards the arc lighting the case is even more favourable, because the 300-watt arc is generally rented at from £20 to £25 per annum, and the difference between this and the above-mentioned working cost is quite sufficient to make an ample provision for paying the interest and sinking fund connected with that part of the capital outlay made for the arc lighting plant alone. I consider that on this portion of the outlay there should be no difficulty in earning 8 to 10 per cent. on the capital outlay after the payment of all working expenses connected with the arc lighting. The arc lighting can, in fact, be made self-supporting.

I should prefer to add to the above estimate for the arc lighting 10 per cent. for the uncertain element in the position of the lights and place the total capital outlay specially for arc lighting plant at £7,260.

(9) Space should be provided in the station for an extension of the arc lighting plant up to 180 or 200 arcs, so as to provide for a practically entire arc light illumination of all the principal streets of the town.

(10) The cost of extension of the power output of the station will not be in the same proportion to the original cost, because the initial outlay will bear certain charges for the whole scheme; but my estimate is that a capital outlay of £35,000 will cover the whole cost of the establishment of the incandescent lighting equivalent to a lamp connection of 10,000 8-c.p. lamps in and about the compulsory area, and that about £7,260 the cost of the arc lighting for 90 300-watt arc lamps in the same district and on the Hoe. The gross revenue to be obtained from this lighting, public and private, should approximate to £7,000 per annum, and the net revenue, after payment of all charges, should leave a margin of £1 500 on the incandescent and £450 on the arc lighting to provide the interest on the loan. When the full capacity of the station—viz., 30,000 8 c.p. incandescent lamps and 200 arc lamps—is taken up, there is good reason to believe that a surplus would remain after meeting the interest on the loan.

On the Employment of Refuse Destructors for Power Purposes.

One question on which I was requested to advise in connection with any proposed scheme for electric lighting at Plymouth is the employment of a refuse destructor for generating steam. In the last eight or nine years widespread interest has been aroused on the subject of refuse destruction in towns, and in connection with the subject attention has been given to the possible utilisation of the power represented by the heat given out by the combustion of this refuse. Very different opinions have been expressed by various authorities on this subject, and I may say at the outset that the greatest caution is necessary in accepting many of the statements which have been made on this subject, and also in applying the experience which has been gained in one place to another.

As your borough surveyor is I understand, engaged in collecting information for a report to you on the whole subject of refuse destruction. I have handed over to him a quantity of information which I had collected together on the subject of refuse destruction and the utilisation of the heat for steam generating purposes. I may say, however, that the broad general result I have derived from the consideration given to this subject is that it would be unwise for the Corporation to embark hastily on any scheme which has for its basis a proposal to establish a refuse destructor solely with the view of generating power for electric lighting. The waste heat from a destructor already existing, or which has to be erected purely on sanitary grounds, may be usefully utilised as an adjunct in generating steam for electric lighting purposes, but the statement which has been made that the ashbin refuse of towns is capable of being made available and sufficient for the whole electric lighting likely to be required, is one which has not at present received sufficient confirmation in fact or experience. The general result derived from the actual experience of refuse destructors is that each cell of a destructor is capable of yielding directly by its waste heat on an average 5 h.p., and that such a cell may consume from five to six tons of ashbin refuse per day without the use of forced draught.

Opinions differ very widely as to the economy and utility of using the forced draught, but if we set on one side exceptional cases, and take the above as an average figure, then it is perfectly certain that an amount of refuse destruction equal to about 30,000 tons per annum cannot possibly yield directly the amount of horse-power required in the electric lighting station at the hour of maximum full load. In order to maintain the 10,000 8 c.p. lamps above suggested, something like 500 h.p. or 600 h p. must be available at the time of maximum load, but the direct heat from the refuse destructor of the capacity required for the consumption of the above amount of refuse would not probably amount to more than 50 h.p. to 60 h.p. The matter would have an altogether different aspect if the power generated by the boilers of the refuse destructor could be stored. A scheme has been put before the Shoreditch Vestry, in London, for utilising the waste heat of dust destructors in combination with a system of steam storage invented by Mr. Druitt Halpin. This system practically consists of large tanks or boilers into which the steam from the destructor boilers is passed, and in which water and steam are accumulated under considerable pressure for utilisation at a subsequent time. This experiment of thermal storage and destruction will be watched with great interest by engineers, but it would, I think, be wise to hold back from following on the same lines until some experience has been gained of the safety and economy of such a system of thermal storage in practice.

The one fact that stands out prominently is that the waste heat of the refuse destructor, furnishing at the rate of 1 h.p per ton of refuse burnt, if utilised directly, is not sufficient to supply the power required for the suggested electric lighting in Plymouth during the hours of maximum demand. It might, however, be utilised during the daytime or hours of night, if the destructor station were placed in contiguity with the electric lighting station.

I therefore suggest in this connection that the plans of your borough engineer with regard to refuse destruction in Plymouth, should hold in view the possible utilisation of the waste heat for part of the power required in the electric lighting station, and that the destructor station and electric lighting station may therefore very conveniently be placed in contiguity on the Cattewater site; but at the same time I hold the opinion that the electric lighting station should be made at first entirely independent, and that the question in the forefront as regards a destructor station should be the sanitary one. There will be no difficulty in making the necessary arrangements to utilise the waste heat from the destructor for steam generating and using it as far as possible in the electric lighting station if the two are placed side by side. If subsequently a system of thermal storage enables us to do more than we can at present do by the combustion of the ashbin refuse, that also can be added, but at the present moment I advise strongly that the electric lighting station be made independent of the other.

At the present time we are able to refer to a number of schemes which have been proposed for the utilisation of the waste heat of destructor cells but an examination of what has actually as yet been achieved does not warrant me in advising the adoption of any of the proposals which have been put forward for depending entirely on refuse combustion for the generation of current for electric lighting. As your borough engineer is dealing with the subject, there is no need to enter into further details as to the manner in which such waste heat as is available can be employed in raising steam.

On the Employment of Electric Traction in Connection with Tramcars at Plymouth.

The third question which I was requested to consider in connection with the public electric supply at Plymouth, was that of operating the tramcars by electricity. There are three systems by which electric traction is now being carried out; these are called respectively the overhead system, the conduit system, and the accumulator system. In the first of these systems an overhead wire is run alongside the tramline track. The tramcars are provided underneath with electric motors; generally speaking, two 15-h.p. motors are used. From the top of the car proceeds a trolley pole, which makes contact with the overhead wire as the car moves along. The car picks up its current from the overhead wire, which, after passing through the motors, is returned by the rails. It is this overhead system which has attained such enormous development in the United States. Of the 12,000 miles of tramway in the United States and Canada, it is said that about as much as 7,200 miles are operated by electricity. Some writers state as many as 9,000 miles. There are 20,000 electric cars, and nearly three-fourths of the tramway movement of the United States is electrical. The capital outlay represented by this development is £45,000,000 sterling.

In the conduit system, the electrical conductor which supplies the current is laid underground in a channel or conduit. A projecting steel bar from the car passes down into the conduit through a slit in the roadway, and makes the necessary contact with the electric conductor; otherwise the arrangement of the car is the same as in the overhead system.

The various difficulties in connection with these two systems are now well understood, and for the most part are overcome. In addition to these two systems, there is a third or accumulator system, in which secondary batteries are carried on the car and supply current for the motor. This system would be an ideal system for the operation of tramcars electrically but for the fact of the greatly increased weight of the car, which, when carrying the accumulators and motors, amounts to from 10 to 15 tons, and that it involves all the special difficulties in connection with the working of secondary batteries, particularly those caused by the incessant jolting of the batteries and the very heavy demand made for current at the moment of starting the car, both of which operate to cause a rapid deterioration of the battery.

Deferring for a moment some further criticisms on the accumulator system, the general description of an electric tramcar system

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operated by overhead conductors is as follows: At some place conveniently situated with respect to the line an electric power station is put down. This power station contains dynamo machines, which generate the current generally at a pressure of 500 volts for tramcar work, and these are for the most part driven by engines of from 300 h.p. to 500 h.p. The tramcars weigh from 8,000lb. to 10,000lb., and carry two 15-h.p. motors. The object of providing this excess of car power is to supply the necessary starting power, especially on gradients. The power is conveyed to the overhead conductor of the trolley wire by underground conductors, called feeders, and when the current has done its work in the motors it is brought back by return feeders from the rails. In order to prevent the current from leaving the rails, and thus causing erosion of gas and water pipes, it is necessary that the rails should be bonded together. In the regulations issued by the Board of Trade for controlling electric traction certain rules have been laid down with respect to the manner in which the rail track shall be constructed, and some of the early difficulties in connection with electric traction arose from the fact that these details had not received sufficient attention. Practically speaking, in order to convert a tramline worked by horses into an electric car line, the track has to be reconstructed to bring it into accordance with these rules, and to render it capable of withstanding the greater wear and tear due to the heavier cars.

There is no difficulty in dealing with very considerable gradients either on the overhead or the conduit system and cars can be made to start uphill on gradients as much as 1 in 10 It is merely a question of sufficient motor power. Objections have been taken to the unsightly appearance of some overhead lines, but there is no difficulty in constructing a neat, well-designed overhead system which is not in the least degree objectionable. Speaking generally, the conversion of a horse-car track into an electric track means relaying of the track and supplying new cars As regards the cost of construction, the following figures have been given as an average specimen of the cost of overhead construction in the United States: the entire track construction, including rails and wires, costs about £1,400 per mile of single track; and the cars, with motors complete, about £800 per car. Thus, for a tramline of five miles in length, operated with 15 cars from one power station, including the cost of building and machinery, the total amount would be something like £27,000. From other estimates and experience it appears that the cost of overhead construction in the more substantial manner required for British city and suburban street tramcars, may be taken to be about £15,000 per mile of double track, including the car equipment, while that of single-track road railway in country districts, if constructed on the metre or 3ft. 3in. gauge, can be kept within £6,000 per mile of single-track.

As an example of total cost of construction of an overhead line of four miles in length, the following figures may be given, being taken from the actual experience in the case of the Marseilles-St. Louis Electric Tramway:

Permanent way	£14,400
Overhead system	10,000
Buildings and plant	11,200
18 cars complete	14,560
Offices	5,800
Miscellaneous	1,840
Total	£57,800

or about £15 000 per mile of double track.

The conduit system involves a far greater outlay, and if one may judge by the experience of those lines already constructed on this system, from £9,000 to £10,000 per mile of single track is certainly within the mark This figure is based on the experience of actual construction—such as the conduit system in Washington-ton, U.S.A., and Chicago, U S A., and includes all cost of car equipment power station, and track.

The conduit system involves considerable reconstruction of the roadways and streets, possible interference with sewers and gas and water pipes, and needs an amount of subway work the cost of which it is very difficult to estimate for accurately beforehand. When this is done there still remains the difficulty of keeping the conduit free from street dirt and storm water, draining it completely and getting convenient access to it all of which difficulties have to be grappled with under the definite local conditions, no general principles being a sufficient guide There is therefore little room for doubt that the only practical system of electric tramcar traction at the present moment is the overhead system. If this is carried out with all the precautions and knowledge now available, I do not consider that an overhead system is at all objectionable. The light iron posts which carry the trolley wires can be made available as supports for arc or incandescent lamps in the streets in which they exist, and with proper regard to the construction of this overhead work there is no reason to believe that it would in any way interfere with other traffic, or be a cause of complaint by its appearance.

As regards the cost of working, a careful analysis of a large number of electric railway accounts shows that the average working cost per car mile, exclusive only of interest on capital, is approximately 6½d. in America and 5½d. in Europe, and that the ratio of working expenses to receipts in both countries is approximately 60 per cent. In contrast to which the working cost per car mile on horse tramways appears to be on an average 10d. per car mile, and the ratio of expenses to receipts over 80 per cent.

The following figures show the total cost of working in pence per car mile for some electric lines, interest on capital alone excepted, the figures being taken from a paper by Mr. Wilkinson on this subject.

Electric Railways.	Pence.
Liverpool Overhead	4·35
City and South London	5·31
Bessbrook, Newry	3·97
Electric Tramcar Lines.	
Roundhay-road, Leeds	5·55
South Stafford Electric	4·06
Guernsey, Channel Islands	4·02

And in comparison with this, the following table for the cost in pence per car mile and ratio of operating expenses to receipts for horse tramways:

Name of horse tramway.	Ratio of operating expenses to receipts. Per cent.	Total cost in pence per car mile.
All London tramways	82·7	9·8
Birmingham, Midland	81·22	13·22
,, Central	76·79	9·96
Dublin United	73·80	9·77
Dundee	73·75	10·78
Leicester	83·78	9·80
Sheffield	79·85	9·95
Newcastle and Gosforth	90·51	11·25

A large number of other figures might, if necessary, be supplied to show the favourable manner in which overhead electric traction compares with horse-car traction in point of cost of working, and the enormous extent to which electric traction has proceeded in the United States is the indirect proof of this fact.

With regard to accumulator cars, it is not possible up to the present time to give a very good account of this system of working, for although many experiments have been made, the greater weight of the cars, the depreciation of the batteries and cars, and the higher operating expenses caused chiefly by the cost of handling the accumulators, amount to about 9d. or 10d. per car mile, have militated against the progress of accumulator traction; and although the advantages of this system of working may continue to make inventors push forward improvements, I cannot at the present moment advise the adoption of battery tramcars as an undertaking on which a municipal authority might safely embark.

On the other hand, there are systems of operating tramcars by alternating currents which have a favourable aspect. Near Dublin, at the present time, a tramcar line is being equipped by the British Thomson-Houston Company, in which three-phase alternating currents will be used for transmitting the power for long distances, and transformer-motors used to convert the alternating current into a continuous one. This system has the great advantage in that the power-house need not be situated very close to the track, because the electric power may be conveyed at a high pressure by small sized conductors to the proper transformation points.

By whatever system the power is conveyed, it must ultimately be utilised by a system of overhead conductors on the tramline, and as the above figures show, the advantages over horse-car traction in cost of working are undeniable.

As regards the situation of the power-house and its relation to the electric lighting station in Plymouth, there is no doubt but that the interests of economical working will be best served by making one electric station do duty for both plants; the same boilers, and the same superintendence and labour would then be available. Taking it that the electric lighting station is established on the Cattewater site, there would be no difficulty in operating an overhead system for electric traction directly from that site over any of the roads running out eastward from the centre of the town. By the employment of a suitable system any of the tramlines could be operated from the site.

My general suggestion as to electric traction in Plymouth is that a careful consideration should be given to this question of operating one line at first electrically in the eastern part of the town by a well-devised overhead system, and that the system of power transmission should be such as to be capable of being extended to lines running out in other directions, if the results warrant further extension. There can be little doubt but that the establishment of one such electric tramcar line worked from a supply station placed on the Cattewater site would show the advantages of electric traction over horse traction in respect of cost of working. My opinion is, however, that the generating machines necessary for supplying the currents for the electric traction should not be the same as those employed for the electric lighting. There are great objections, owing to the sudden fluctuations in the demand for traction power, to employing the same engines and dynamos for both lighting and traction, though steam for both plants might be supplied in one common battery of boilers.

The figures that I have given above as to the average cost of construction of an overhead system would be a guide to estimate the probable cost of converting, say, three miles of any tramcar line from the horse-car system to the electric traction system. If, however, the electric current is supplied from the same station there would be a certain reduction to be made in these figures, which could only be calculated when the exact position of the line to be operated electrically was known.

The same general advice which I have given with regard to the electric lighting station would apply to the electric traction station—namely, whatever designs were considered should from the very first be drawn with a view of ultimate considerable extension without any alteration of that which is already in place. With the limited data before me, it is not possible to do more than to sum up the electric traction question as regards Plymouth in the following conclusions.

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1. That there will be no difficulty in supplying the necessary power to operate any tramcar line from the same electric station that supplies current for electric lighting, but separate engines and dynamo machines will have to be employed.

2. That such combined power and lighting station could be placed on the Cattewater site.

3. That it would be desirable to restrict the initial outlay to the conversion of one line of track of some reasonable length from a horse-car to an electric traction system, such line being selected with a view of facilitating as far as possible, not only passenger passenger traffic, but also bringing in and out of Plymouth marketable commodities. The gradients which will be met with will not present any obstacle to a successful system of electric traction.

4. The selected system should be the overhead system. The accumulator-car system is hardly in a condition as yet to enable me to make a recommendation upon it. The conduit system is in my opinion unsuitable, partly on account of the high initial expense, and the very considerable cost of the reconstruction of the roadway, as well as on the ground of the difficulties that would probably be met with in securing the proper drainage of the conduit, and keeping it free from accumulation of street rubbish.

5. I do not feel justified in making any general recommendation as to the working of all the Plymouth tramlines by electricity at once, but I consider that on one of the tramlines having the heaviest traffic, and preferably in the eastern part of the town, the adoption of an electric service by the overhead system would be of unquestionable advantage.

6 There are two methods by which the distribution of power electrically for traction purposes for the whole of the Plymouth tramways could be carried out from a power station situated on the Cattewater site. One of these is the system in process of adoption near Dublin, in which alternating currents are transmitted to transformer centres and then transformed into 500-volt continuous currents for use on the overhead tramline. The other system involves the use of stationary secondary batteries in connection with a similar transformation, and is, I believe, being adopted in the Isle of Man with very good results.

7. I should prefer to reserve an opinion as to the precise details of the system to be adopted, as well as a particular estimate of cost, until the general question has been settled which of the Corporation tramways it is advisable should be first operated electrically. It is impossible to estimate the details of capital outlay, revenue, and working costs until the nature and position of the line, the car service, and full particulars of the traffic are known.

COMPANIES' MEETINGS AND REPORTS.

FROGGATT'S ELECTRIC LIGHTING COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on Monday last at Winchester House, E.C., to consider the following resolution: "That, on the suggestion of the directors and in the opinion of the shareholders, it is desirable that a committee of the shareholders be appointed to confer with the directors on the following subjects: (*a*) the conduct of the business in the past and the causes of a dividend not having been earned; (*b*) the conduct of the business in the future and the steps to be taken to promote the business success of the Company; and that such committee be empowered, if in its discretion it thinks fit, to make a report to the shareholders." Mr. A. de Murrieta, chairman of the Company, presided.

The Chairman, in moving the resolution, said that it was done in accordance with what was indicated by the Board at the last general meeting. They had not come with a prepared list of names for the committee, as they wished the appointments to be made wholly on the initiative of the shareholders.

Mr. H. Keeble wanted to know why they were to appoint a committee. No grounds for it had been given.

Mr. Wildey thought that on that point the report presented at the last meeting spoke for itself. They had made a profit of only £239 in 12 months, and of that he himself could account for £50 or £100. They saw the Company's lights in omnibuses, and they heard of contracts, and the shareholders naturally wanted to know where the money had gone to. Had they been illuminating those omnibuses for other persons' benefit or their own? He seconded the resolution.

Mr. H. Keeble thought the appointment of the committee would be useless after the report of the directors had been accepted. It was practically as though the directors were to say, "We have managed the Company up to the present time; now we are incompetent to carry it on. Tell us what to do." The proposal was either a simple waste of time, or an attempt to wreck the Company. He proposed as an amendment that the committee should report to the shareholders.

Mr. Hayward seconded this, with the addition that the report should be presented within 28 days.

The **Chairman** said the Board would oppose the limit of 28 days, otherwise they did not object. The purpose of leaving it in the discretion of the committee to report was because they might have to discuss certain matters which it would not be for the interests of the Company to make public.

Upon a show of hands, the amendment was lost and the original resolution carried.

Mr. H. Keeble demanded a poll, and three shareholders being necessary for that purpose, Messrs Hayward, Baxter, Lyons, and Partridge joined in the demand.

The **Chairman** appointed the following day for the poll, and the meeting was adjourned to Thursday at four o'clock.

At the adjourned meeting on Thursday, Mr. A. de Murrieta presiding, the result of the poll was declared as follows:

For the resolution	19,224
Against	11,578
Majority	7,646

Mr. Stanhope, Mr. C. Hunter, and Mr. Hayward were appointed the committee.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY, LIMITED.

The directors, in their report for the half year ended June 30 last, state that the gross receipts, including Government subsidies, have amounted during that period to £264,138, against £247,681 for the corresponding half-year of 1894 The working expenses, including £29,323 for cost of repairs to cables and expenses of ships, absorb £95,254, against £80,295 for the corresponding period of 1894, leaving a balance of £168,883 From this is deducted £3,984 for income tax, £31,895 for interest on debentures, debenture stock, and contributions to sinking fund, leaving £133,004 as the net profit for the half-year. Two quarterly interim dividends of 1¼ per cent. each, amounting to £62 500, have been paid for the half-year under review, leaving £70 504 to be carried forward. The working of the Australasian tariff arrangement for the fourth year of guarantee, ended April 30 last, resulted in the guaranteed figure being slightly exceeded, owing to the exceptionally heavy gold-mining traffic that was exchanged with Australasia during the latter part of the year. The maintenance ships have, as usual, been kept employed during the half-year under review on the various sections of the Company's cables; but owing to the cables being duplicated, the traffic has in no instance been interrupted.

MONTE VIDEO TELEPHONE COMPANY.

The directors, in their report for the year ended July 31 last, state that the accounts show a net profit for that period of £7,232. This amount added to the balance of £577 brought forward from last year leaves a sum of £7,810 available, after providing for all the working expenses in Monte Video and London and for loss in exchange, and after writing off amounts for bad debts and depreciation of office furniture. The working expenses in Monte Video have been somewhat heavier during the current year, the increase being attributable to a succession of severe storms during the early part of this year, when much damage was done to the plant. At the cost of revenue, however, the property has been maintained in good working order. After placing £1,000 to reserve account and £500 to the depreciation fund, the directors recommend the payment of a dividend of 4 per cent. on the preference share capital, leaving the sum of £710 to be carried forward to next year.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ceva (Italy).—The Municipality of Ceva, Mondovi-Cuneo, invite offers for lighting the town by electricity. Address, Il Municipio di Ceva.

Guernsey.—The Guernsey Railway Company, Limited, invite tenders for two electric motor bogie cars, with top transverse seats and reversible backs, to seat 80 persons and suitable for the overhead wire system. Particulars can be obtained on application to the secretary, Guernsey.

Madrid.—The Director of Public Works invites tenders by November 15 for the concession of the construction and working of a tramway from Madrid to Colmenar Viejo, with branches to Chamartin and Rosa. Security, 12,505 pesetas. Particulars at the Direccion General de Obras Publicas (Ministerio de Fomento), Madrid.

London, E.C.—The Great Indian Peninsula Railway are prepared to receive tenders, among other railway stores, for telegraphic stay rods and miscellaneous wire. Specifications and forms of tender are to be obtained from the company's offices, Copthall House, 48, Copthall-avenue, E C., and tenders must be sent in by the 31st inst.

Bedford.—The Bedford Urban Sanitary Authority invite tenders for the supply and delivery of a surface condenser with air pump, and of a centrifugal pump with engine. Specifications can be obtained at the office of Mr. T. S. Porter, clerk, Town Hall, Bedford, and tenders, marked "Electricity," must be delivered to the clerk by November 1.

Saltash (Cornwall)—Tenders are wanted for lighting with gas, electricity, or otherwise the public lamps in the borough from January 4, 1896, for such term as may be agreed upon, for the Saltash Town Council. Number of lamps 81, with every prospect of the number being considerably increased at no distant date. For particulars apply to the chairman of the Works Committee, Mr. W. V. Alford, 3, Springfield-terrace, Saltash, to whom sealed and marked tenders should be sent by 26th inst.

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Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

London, E C.—Tenders will be received at the General Post Office, London, E.C., until noon on 28th inst. (a) for supply of red fir telegraph poles, to be delivered in London. King's Lynn, or Sutton Bridge, and at Northumberland Dock (River Tyne), West Hartlepool, Hull, or Grimsby; and (b) for creosoting the poles with 10lb. or 12lb. of creosote to the cubic foot, as may be directed. The poles to be felled between November 1, 1895, and February 29, 1896, and to be delivered during the following summer at the port at which the creosoting is to be performed. Butt sections, from not less than three poles, to show the quality of timber offered, must precede or accompany the tender of any person who has not already supplied the Postmaster-General with poles. Forms of tender, containing all particulars, may be obtained on application to Mr. Chas. E Stuart, controller of stores.

RESULTS OF TENDERS.

Stafford.—The amount of the accepted tender of Messrs. Drake and Gorham, of 66, Victoria-street, Westminster, for wiring the Staffordshire County Infirmary, given in our last issue as £397, should, we are informed, be £403.

Harrogate.—Seventeen tenders were received for the electric wiring of the new baths (the wires to be carried in tubes or conduits embedded in a plaster, and to provide 433 lamps to be arranged in circuits), and the tender of Messrs. Paterson and Cooper, of London, for £412, was accepted; the tender of the National Telephone Company was also accepted for fixing telephones in four positions in the new building.

Richmond (Surrey).—Tenders for fire-calls extension to Kew and Petersham, for the Richmond Town Council, resulted as follows:

Newland and Co.	£371	0	0
Harrison, Coles, and Co.	317	5	0
Consolidated Telephone Company	299	10	0
J. Sax and Co.	250	0	0
For cables only.			
Callender Company (accepted)	165	6	0
For instruments only.			
Stewart	46	7	6

Croydon.—The following tenders have been received by the Town Council for wiring and supplying and fixing electrical fittings at the new Town Hall, Courts, and Free Library:

H. Binko and Co., 34, Leadenhall-street, E.C.	£1,124	15	0
Wenham and Waters, Paragon Works, Croydon (accepted)	1,253	0	0
S. J. Waring and Co., Limited, 181, Oxford-street, W.	1,325	10	0
Spagnoletti and Crookes, Goldhawk Works, Shepherds Bush	1,450	0	0
Vaughan and Brown, 16, Kirby-street, E.C.	1,455	0	0
Roger Dawson, Limited, 63, Berners-street, W.	1,467	10	0
Paterson and Cooper, 3, Princes-mansions, Victoria-street	1,530	10	0
Strode and Co., St. Paul's-churchyard, E.C.	1,537	0	0
Lund Bro. and Co., 123, Oxford-street, W.	1,548	0	0
New and Mayne, Palace-chambers, S.W.	1,5?0	0	0
Edmundsons, Limited, 19, Great George-street, S.W.	1,643	0	0
Hollingum and Saward, 31, Holborn-viaduct, E.C.	1,675	0	0
H. F. Joel and Co., 31, Wilson-street, Finsbury, E.C.	1,688	17	0
A. C. Hands, 194, Upper Thames-street, E.C., and Page and Miles, 60, Western-road, Brighton	1,743	5	0
Fowler, Lancaster, and Co., Albert Works, Birmingham	1,775	0	0
Graham and Biddle, 461, Oxford-street, W.	1,776	12	10
Peto and Radford, Hatton-garden Electric Works, E.C.	1,824	0	0
Laing, Wharton, and Down, 17, Gracechurch-street, E.C.	1,861	1	9
Rashleigh Phipps and Co., 102, Oxford-street, W.	1,880	0	0
Winfields, Limited, Cambridge street Works, Birmingham	1,980	0	0
Pettitt and Hards, 2, Duke-street, Adelphi, W.C.	2,070	0	0
Smeeton and Page, 63, Queen Victoria-street, E.C.	2,250	0	0
J. S. Cunnington and Co., 5, John-street, Adelphi, W.C.	2,439	0	0
Hirst and Co., St. Michael's-road, Croydon	2,685	0	0

Brussels.—The following were the tenders for the supply of cables and copper wire (bare and covered) for the Telegraphic Service, specification No. 24.

For 1,300 to 2,000 metres of house wires (two conductors), 1,200 to 1,600 metres ditto (six ditto), 300 to 400 metres of river cable (two ditto), 700 to 900 metres ditto (four ditto), 1,500 to 1,800 metres of submarine cable (six ditto):

	francs.
L. Hen et Cie., Schaerbeck	13,019
Felten et Guilleame, Mulheim	13,147
G. Boty, Brussels	15,055
Société industrielle des Téléphones, Paris	15 333
S. Hirschmann, Berlin	15,501
Clouth, Cologne	16,978

For 675 to 900 kilogrammes of annealed copper wire, diameter 1·2 millimetre; 200 to 300 kilogrammes ditto, diameter 1·6 millimetre; 300 to 450 kilogrammes ditto, diameter 2 millimetres; 155,000 to 200,000 metres of guttapercha-covered copper wire cased with white and brown cotton; 87,000 to 110,000 metres ditto cased with asphalted cotton; 30,000 to 55,000 metres ditto, with a layer of coloured incombustible cotton; and 2,500 to 3,500 metres of flexible two-wire conductors:

	francs.
L. Hen et Cie.	23,267
Even, Liège	23,675
Felten et Guilleaume	25,843
Clouth	33,681
Société industrielle des Téléphones	35,750
S. Hirschmann	38,553

London, E.C.—The tender of Messrs. F. A. Glover and Co., of 97, Queen Victoria-street, E.C., at £369, for the electric wiring of the Cripplegate Institute has been accepted. Mr. H. B. Jenkinson is advising the governors as consulting engineer.

BUSINESS NOTES.

Salisbury.—Steam was turned on at the new electric light works at Salisbury on Monday last by Mr. E. R. Dale, A.I.E.E.

Walsall.—The Town Council have decided to borrow £1,200 from the Qui Tercentenary Fund Trustees for electric lighting expenses.

London (St. George's).—The surveyor of St. George's, Hanover-square, Vestry is preparing a general report on the subject of the electric lighting of the district.

The Electric Light in South Africa.—Messrs. Delfos Bros., of Pretoria, have entered into a contract with the Bloemfontein Town Council for supplying the town with the electric light.

Electric Tramways in Brazil.—It is stated that the Companhia Ferro Carril Carioca has contracted with the General Electric Company of New York for electric cars on its tramway.

Birmingham.—There is a possibility of the Birmingham City Council giving consent to a trial of the overhead electric traction system upon the Nechells route by the Central Tramways Company.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended 20th inst. amounted to £1,104, as compared with £888 in the corresponding week of last year, being an increase of £216.

Govan (Lanark).—The District Lunacy Board have discussed the question of the lighting of the new Hawkhead Asylum Hospital, but a proposal for a committee to enquire as to the introduction of electric light was lost.

Dover.—A special meeting of the Town Council is to be held on November 9 to approve of an application to the Board of Trade for a provisional order authorising the Corporation to construct tramways in the borough of Dover.

Western and Brazilian Telegraph Company, Limited.—The traffic receipts of this Company for the week ended October 18, 1895, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,009.

Wolverhampton.—The Coseley District Council having considered their surveyor's report on public lighting have decided to adopt gas, an amendment that the district be canvassed to ascertain if the majority of ratepayers were not in favour of electricity being rejected.

The Eastern and South African Telegraph Company, Limited, announces the payment by warrants, on November 1, 1895, of interest on the 4 per cent. Mauritius subsidy debentures. The transfer books will be closed from October 27 to November 1, both days inclusive.

Hartlepool.—With regard to the Hartlepool tramways, the track is being relaid, the electric connections made, and the trolley poles are being erected by the Electrical Construction Company. It is expected that the cars will be running by the end of the year.

Brockie-Pell Arc Lamps.—We have received from Messrs. Johnson and Phillips, of Charlton, Kent, and Union-court, Old Broad-street, E.C., a new catalogue of the Brockie-Pell arc lamps made by them, in which attention is directed to the greatly reduced prices of the lamps.

Hamburg.—A travelling bridge on the suspension principle across the Elbe at Hamburg is under contemplation. There will be three electric cars—two for carriages and horses, and one for foot passengers. The span is 1,350ft., and there will be a clear head of 130ft. above the river.

Heaton Norris (Stockport).—The Electric Lighting Committee of the District Council have discussed the subject of obtaining a provisional order for lighting this district with electricity, and a letter from Mr. Cobbett, clerk to the Wilmslow District Council, was read. The matter was deferred for further consideration.

City and South London Railway.—The returns for the week ended October 20 were £927, compared with £932 for the corresponding period of 1894, being a decrease of £5. The total receipts for the half-year 1895 are £13,701, compared with £13,863 for the corresponding period of 1894, being a decrease of £162.

Berliner Elektricitats-Werke.—The directors will propose at the ordinary general meeting of this concern to be held on October 30 that a dividend of 12½ per cent., against 10½ per cent. in the previous year, be paid. The net profit amounts to 1,596,459 marks, against 1,293,057 marks; and 830,264 marks, against 813,848 marks, are written off.

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Harrogate.—It has been stated in the Town Council that the whole of the estimates for the electric lighting installation in the borough would amount to £27,000 instead of £25,000, as previously thought. The present contracts amount to £13,202. The town clerk has been authorised to borrow £2,000 in addition to the sum authorised at the last meeting—viz, £25,000.

Canadian Electrical Association.—At the fifth annual convention of this association recently held at Ottawa, the address of the president, Mr. K. J. Dunstan, dealt mainly with electrical works and improvements executed during the year. With regard to electric carriages, he considered that indications pointed strongly to our "being on the verge of a horseless age."

Cardiff.—We hear on good authority that the short interruption in the electric supply on Friday evening last was due to the breaking of a valve spindle in one of the engines. As the alternators were running in parallel, this accident temporarily stopped the supply; but, owing to the energy and promptitude of the engineers in charge, the pressure was on the mains again within five minutes.

Bristol.—On the suggestion of Mr. Howes, a resolution of the Kingswood Urban District Council, passed a month ago, was rescinded, and plans submitted by the tramways company for the extension of the line to Warmley-hill were approved. The added line will be double from the gates of the flower show field to the top of the hill, and will be laid in the centre of the road. Work has been commenced.

Electric Sign and General Advertising Company, Limited.—This Company was registered October 12, with a capital of £5,000 in £1 shares. Objects: to enter into an agreement with Messrs. G. C. Fricker and A. W. Poulton for the acquisition of the business carried on by them at 46, Queen Victoria-street, E C., as manufacturers of and dealers in electrical and other advertising apparatus, and to carry on and extend the same.

Wimbledon.—The District Council have received two letters from the Ratepayers' Association, enclosing resolutions opposing the electric lighting scheme, and appealing to the Council not to pass it until the ratepayers had had an opportunity of passing an opinion upon it. A letter was also received from the Local Government Board stating that the enquiry would take place as soon as the other engagements of the inspector would permit.

Colwyn Bay.—The District Council have unanimously resolved that application be made to the Board of Trade to grant to the Council a provisional order authorising the Council to supply electricity within the whole of the urban sanitary district of Colwyn Bay and Colwyn. It was further resolved that all the members of the Council be appointed a committee to carry out all necessary steps in furtherance of the resolution with power to act.

Ilfracombe.—The Ilfracombe District Council have decided that no further steps be taken in connection with the proposal to promote a Bill for securing the compulsory purchase of the gas company's undertaking. The Council are acting wisely in considering the alternative of introducing the electric light as a means of street illumination into the town, and the surveyor has been instructed to furnish a report on the subject of electric lighting.

The Aluminium Company.—The Aluminium Company, which secured the Falls of Foyers, is, it is stated, negotiating for the water power of the Falls of the Clyde. The Company propose to use the Bonnington and Corra Linn Falls, leaving Stonebyres alone. The negotiations have proceeded satisfactory so far as the Aluminium Company is concerned, although a slight hitch has occurred with one of the proprietors of the estates on which the falls are situate.

Halifax.—A large party, consisting of ladies and gentlemen, members of the Halifax Scientific Society, were conducted the other day through the borough electricity works by Mr. T. P. Wilmshurst, the electrical engineer. While the members were assembling in the office adjoining the works, some novelties in the way of incandescent lamps with tinted bulbs were objects of universal admiration, the effect produced by them being very pleasing and artistic.

Fulham.—The Vestry's Special Committee on Electric Lighting have given the clerk instructions as to inviting six expert electrical engineers to attend before them with a view of appointing one to advise the Vestry, at a fee of £50. The Vestry has decided to oppose the application of the Capital and Counties Electricity Supply Company, Limited, for a provisional order to supply electricity for public and private purposes with the area of the jurisdiction of the Vestry of Fulham.

New Cables in Lower Burma.—New cables have been laid to Diamond Island, seven miles, and across the Irrawaddy at Yandoon and at Myanoung. The first and last replaced faulty cables; the one at Yandoon was for the Yandoon Daimbyu circuit. Cables have failed again at Kemmendine, and it has therefore been decided not to lay new ones there, but to erect spans instead over the Hlaing and Paulang creeks, about a mile above the present crossing. The Kyauktan cable failed during the year and was abandoned.

New Cell.—We have received from the Chloride Electrical Storage Syndicate, Limited, of Clifton Junction, near Manchester, a price-sheet of their new "R" type cell, which is fitted with a new type of plate they have lately brought out. These cells are, we are informed, capable of being discharged at very high rates, and can with ease be charged in four hours; a great saving can therefore be effected in the time formerly necessary for charging. The price of these cells is, we understand, low compared with their great durability.

Queenstown.—The Town Commissioners have instructed their solicitor to take all necessary steps in "order to obtain a provisional order from the Board of Trade to enable the Commissioners to erect works and plant to supply electric light within the township." Mr. Campbell mentioned that Mr. Handley, of the firm of Handley and Shanks, Cork, had spoken to him of the desirability of erecting four arc lamps in the town as an experiment; and it was decided, subject to the expenditure being legal, to do this.

Swansea.—Mr. Viner Leeder gave notice of a motion rescinding the resolution of the Council adopting the electric lighting scheme. The Mayor said he must rule the motion out of order, as the matter had already been decided twice within a municipal year. Mr. Leeder said he would submit to the ruling. He understood that the Electric Lighting Committee had met since the last Council meeting, and that there were some suggested alterations. He did not know whether he was right. It was the only information he had received. If that was so he would willingly drop it and not press for information now.

Leeds.—A correspondent writes to a local paper: "Having travelled upon electric trams in several American cities during the last few weeks, I venture through the medium of your columns to suggest to the city authorities that they obtain information respecting the system now working in Detroit. The most prominent feature is the wonderfully smooth travelling which obtains there as the result of the rails being laid in concrete and welded together so as to form continuous rails, in some cases of several miles in length. I trust to find that in the early future Leeds will be in possession of one of the finest tram systems in the world."

Bradford.—The Corporation have received a further letter from Mr. Isaac Smith on the subject of the terms on which the Corporation should experiment with the Dvorkovitz oil-enriched gas. Mr. Smith offered to bear the cost of extra fire insurance premiums, if any. The letter was referred to the Gas and Electricity Supply Committee. Subsequently, on the minutes of this committee coming up for discussion, Alderman Morley proposed that the question be settled at once and Mr. Smith's offer accepted, but in view of the previous decision this was ruled out of order. The matter will accordingly go to the new committee to be appointed after November 9.

City of London Electric Lighting Company, Limited.—The revenue from the sale of current for public lighting for the quarter ending September was £3,182, compared with £3,141 for the corresponding period of last year; and for private lighting, etc., £11,600, against £7,676; the estimated income from other sources being put at £400, as compared with £416; making the total revenue £15,182, against £11,233, or an increase of £3,949. The equivalent of 8-c.p. lamps connected on September 30 was 170,827, an increase during the quarter of 11,577, the equivalent on the same date of 1894 being 114 031, and the increase during the corresponding quarter 13,724.

Indian Telegraphs.—The *Madras Mail* says: "The telegraph authorities deserve great credit for the promptness with which they have established through telegraphic communication between Madras and Bombay. The lines were submerged between the 370th mile and the Bori Bridge. A party started at once for the scene and divided at the 370th mile, half staying there, the rest with great difficulty going on to the Bori Bridge, carrying stores with them. They reached there yesterday, and by 3 30 p.m., after great trouble, and with the exercise of a good deal of ingenuity managed to rig up a temporary span and restore through communication, for ordinary and urgent messages at least, between Madras and Bombay."

Glasgow.—The Police Commissioners have considered the report of the Watching and Lighting Committee stating that, on the suggestion of Bailie Guthrie the committee remitted to a sub-committee to consider and report on the question of the electric lighting of the city, and particularly on the kind of lamp to be used for such lighting. Mr. Nelson said he was glad to see a remit to a sub-committee to consider the electric lighting of the city and the kind of lamp to be used. They had thus anticipated his motion referring to the unsatisfactory way in which the principal streets were lighted, and he would be quite content to accept it if the committee could add the name of Mr. Arnot to the committee. The Chairman said that would be done, and the report was then approved.

Bexhill (Sussex).—The Urban District Council have received from Messrs. Cope and Son a formal notice that Lord Cantelupe and another gentleman intend to apply for powers under the Electric Lighting Acts of 1882 and 1888 to introduce the electric light into Bexhill, and asking the consent of the Council to such an application. The consent of the Council, it appeared, was not really necessary, and was asked out of courtesy. Mr. Young saw no reason why the assent of the Council should be withheld if a clause was inserted giving the Council the power to purchase at a certain price at any time they might wish to do so. He moved an amendment to that effect. The amendment, having been seconded, was put and lost, the original motion being carried with two dissentients.

Spanish Customs Regulations.—The Spanish Chamber of Commerce in London, 23, Billiter-street, E.C., inform us that the said Chamber will prepare and certify in the Spanish language the certificates of origin of British goods to be sent to the Spanish kingdom in accordance with the new regulations issued by the Spanish Government, and which will be enforced from November 1 prox. To facilitate its despatch at the Spanish Custom Houses, this Chamber has, for the inspection of shippers, the Spanish Custom House tariff in both languages, Spanish and

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English, with the equivalent weights and measures of the two countries. The form of the certificates to be given by the manufacturers and producers of goods to be shipped to Spain will also be provided by this Chamber.

Newcastle-on-Tyne.—The Town Improvement Committee of the Newcastle Corporation have definitely decided to recommend the City Council to adopt the cable system of tramways, and have drawn up a report for confirmation. It appears to the committee to be essential that, as far as practicable, the lines of tramway to be worked by cable should be double lines. The cost of laying the cable tramways comprised in the scheme, including engine-houses, engines, track, and conduit, but exclusive of cost or value of land for power station, is estimated at about £125,000 On the report coming before the Council for confirmation, a discussion took place, during which the Council was urged to follow the example of Leeds and adopt the electric system, and the meeting was adjourned to consider the matter further.

Liverpool.—The Marine Committee of the Dock Board have recommended that the Prince's Landing-stage should be lighted by electricity, at an estimated cost of £500, to facilitate the landing of passengers and luggage from the American liners. Mr. Bushell moved, and Mr. Gladstone seconded, the confirmation of the recommendation. Mr. Fernie asked whether it would not be desirable to extend the electric light along the whole length of the stage. It could be done for an extra £200 or £300. The Chairman: That is a matter which we will take into consideration. The recommendation was then confirmed. It was decided, at the suggestion of the Docks and Quays Committee, to provide two electric lights at the east side of the Canada lock and one at the west side of the new passage between the Canada and Hus kisson Docks, at an estimated cost of £500.

Islington, N.—The Electric Lighting Committee of the Vestry have reported that the sum of £60,000, the original estimate for laying down an installation of electric light in the parish, had been arrived at without professional assistance, and it had since been found to be inadequate. They therefore submitted an account of their expenditure up to the present date, which showed that a sum of £50,790 9s. 3d. had been spent on the works, and, in addition to the £15,000 they had in hand, they required a further amount of £25,000. The committee asked the Vestry's sanction for borrowing this amount from the London County Council, repayable within a period of not less than 42 years, at a rate of interest not exceeding 2½ per cent. per annum. After a long discussion the Vestry sanctioned the proposal to borrow the money. The Vestry have, in connection with their electric lighting scheme, already received applications for 9 237 8-c p lamps.

Denbigh.— Representatives from the Edison-Swan Electric Lighting Company have attended a meeting of the Lighting Committee of the Town Council and explained the terms upon which their company would undertake to supply the town with electric light—viz, that if the Council would find the money required, the company would build a station, supply all plant, etc, and take a lease for 30 years or any other term to be agreed on, work the lighting system for that term, and pay a rent for the same which would be sufficient to cover the initial outlay, depreciation, and interest, and at the end of the term the station and plant would become the property of the Corporation. They also explained that the electric lighting would effect a saving of 20 per cent. in the expenditure. The committee went into the matter, and it was resolved that it be laid before the whole Council. The whole subject was referred back to the Lighting Committee for consideration to report.

Barnet (Herts.).—The clerk to the Urban Council has reported that he had obtained information from several quarters bearing on the question of electric lighting. Mr. Schmidt moved that the letters should be referred to the General Purposes Committee. Mr. Martin Pooley seconded. The Rev. G Bampfield opposed, because, he said, that committee was, for such a question, unfairly and improperly constituted. If the letters must go to committee he asked that a special committee should be formed. He maintained that the General Purposes Committee had not had the whole question delegated to them. Four members had been returned on the recommendation of the Ratepayers' Association, and one of their first objects was to oppose anything like experimenting with electric lighting He contended that one-third of the committee should have been taken from these members, so that the question might be fairly treated. As a matter of fact, only one of them sat on the committee. The Rev. G. Bampfield alone voted against the motion to refer the letters to committee, and the motion was accordingly carried.

Weybridge.—The Urban District Council have received the following letter from the Board of Trade: "In reply to your letter enquiring whether the electric supply order can be transferred to the Urban District Council, and upon what terms, I am directed by the Board of Trade to refer you to the provisions of Sections 64-67 of the order, a copy of which is enclosed herewith." Of these sections the most important was the sixty-sixth, which is as follows: "The Board of Trade may revoke this order at any time, with the consent and concurrence of the undertakers and the local authority, upon such terms as the Board of Trade may think just." Mr. Chambers thought they had better let the matter drop. Mr. Bilney did not consider they should do that, and the Chairman remarked that it would cost £200 to get a new order. He (the chairman) thought they should see what arrangements could be made with the undertakers. Several members concurred with this view, and the clerk was instructed to write to Mr. Martindale, referring him to Clause 66, and asking upon what terms it could be arranged that the order should not be revoked, but transferred to the Council.

Brazilian Submarine Telegraph Company, Limited.—The report for the half-year ending June 30, to be submitted to the ordinary general meeting on October 30, states that the revenue amounted to £108,205, and the working expenses to £21,129. After providing £3,200 for debenture interest and sinking fund, and £1,790 for income tax, there remains a balance of £82,086, to which is added £4,324 brought forward, making a total of £86,410. A quarterly interim dividend, absorbing £19,500, has been paid, and £30,000 transferred to the reserve fund. The directors now recommend the declaration of a final dividend of 3s. per share, making, with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 2s. per share, both free of income tax, which together will amount to £32,500, leaving a balance of £4,410 to be carried forward. The receipts include £1,500 dividend to December 31 last on the shares in the African Direct Telegraph Company, Limited. The various sections of the lines are in good working order.

Killarney.—The Asylum Committee have received a letter from the Board of Control informing the Governors that they will take the necessary steps to provide a suitable dining-hall for the asylum, and with regard to the contract to be made with the electric light company for the supply of the necessary current for lighting the asylum, they also beg to inform the Governors that this arrangement does not fall within the province of the Board of Control. It is a matter for the Governors to arrange through their solicitor, but if the Board of Control can give any advice with regard to the terms and conditions of this contract it will be happy to do so. Mr. Leahy proposed a resolution asking the solicitor to the Board, Mr. Downey, to approve of the draft agreement between the medical superintendent of the Board of Control and the electric light company for lighting the asylum. The resolution was adopted. Mr. Leahy handed in the following notice: "I hereby give notice that at the November meeting of this Board I shall move that we then complete the agreement with the Killarney Electric Lighting Company, the draft of which we have now sent to our solicitor for approval."

Brighton.—The Works Committee of the Town Council have again had before them the application of the Brighton and Rottingdean Electric Tramroad Company for permission to erect 13 steel poles on the foreshore of the borough. The settlement of this vexed question has been in abeyance for some time now. The company have the permission of the Board of Trade to the erection of the poles between Rottingdean and the borough boundary, but of course it is essential that the system should be continued to the terminus, and the consent of the Council is necessary to the erection of the poles along the small piece of the line which lies within the borough. The committee decided to again adjourn the consideration of the subject. On the occasion of the carnival and parade on Thursday evening, October 24, arrangements have been made for the illumination of the Madeira-road by two arc lights erected almost opposite the entrance to the Chain Pier. Mr. Wright, the superintendent of the Corporation electricity works, has also endeavoured to secure a searchlight to be affixed on the top of the Aquarium for use along the road, and a searchlight to be employed from the top of the shaft in Glo'ster-road to illuminate the space about the entrance to the Aquarium.

Dublin.—The project locally known as "Rathmines to the Sea" is in a fair way of realisation, judging from the practical and representative meeting recently held. On that occasion Mr. J. H. Ryan, M I.C E, who was accompanied by Mr A. E. Porte, electrical engineer, and Mr. E. Liller, traffic expert, explained the route of the proposed line, which would be as follows: Starting from the post office at Castlewood-avenue through Charleston-road, Ranelagh, Chelmsford-road, Appian Way, Clyde-road, to Ballsbridge, thence to Sandymount and Merrion. Mr. Porte explained in detail the system of electrical propulsion proposed to be adopted, which would entirely obviate the necessity of poles and overhead wires, a system which was rapidly being adopted on the Continent, as costing much less than that of horse traction, etc. Mr. Liller also laid before the meeting statistics showing that the probable earnings of the line, on a very moderate estimate, would be sufficient to pay 5 per cent. of the original capital outlay. It is understood also that a sub committee was nominated, and a guarantee fund opened, Mr. Mullen, manager, National Bank, Rathmines, having consented to act as treasurer. The line would extend from the head of Rathmines-road to Ballsbridge, where it would strike the existing electric line to Merrion. The cost is estimated at £14,000.

New Issue—The Castner-Kellner Alkali Company, Limited, has been formed with a capital of £300,000. in £1 shares, in view of an arrangement made between the Aluminium Company, Limited, of London, who are the owners of the Castner patents, and Messrs. Solvay et Cie., of Brussels, who are by purchase the sole owners of the Kellner patents (except for Austria), for the purpose of working in Great Britain, Ireland, and the British Colonies, excepting Canada, the combined patents of Mr. Hamilton Y. Castner and Dr. Carl Kellner, for the manufacture of caustic alkali and bleaching powder by means of the electric decomposition of salt or alkaline salts. The prospectus states that Messrs. Solvay authorise the Aluminium Company to announce that the two companies have agreed to exchange their patents; that the working of the Castner-Kellner processes has been reserved to the latter for the United Kingdom and the British Colonies; that all improvements will be exchanged for a term of 12 years; and that the two firms intend to work in accord on commercial matters during that period. The purchase price to be paid to the Aluminium Company for the patents and the benefit of the agreement with Messrs. Solvay has been fixed at £125,000, payable as to £25,000 in cash and £100,000 in fully-paid shares.

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It is said that the Castner process has been successfully worked for a year past at the Aluminium Company's establishment at Oldbury, near Birmingham.

Traction Companies in Philadelphia.—After deliberations extending over a period of two months, the big traction amalgamation has finally been consummated and the three extensive local street railway systems—the Philadelphia, Electric, and People's—joined together under the title of the Union Traction Company of Philadelphia. All the necessary papers have now been executed, and the lease of the Philadelphia Traction Company to the Union Company has been signed by Presidents John Lowber Welsh and Peter A. B. Widener. The deal was virtually effected two months ago, but since that time obstacles have arisen in the negotiations that prevented their consummation then ; but the last stumbling-block has now been surmounted, and the three big lines, forming the most extensive street railway system in the country, will be operated under one executive head. By the terms of the lease the Philadelphia Traction Company, including all its allied lines, controlled or owned. will be leased to the Union Traction Company for 999 years, the Union Company to assume virtually all the obligations now binding upon the Philadelphia Company, and to pay the latter company a rental which will yield the stockholders dividends of 8 per cent per annum. All that is now necessary to formally carry into effect the triple agreement is the action of the People's Traction Company stockholders on the question of reducing the capital stock so as to come within the provisions of the Act of Assembly. The deal as ratified forms the greatest single system of street railway lines in existence, with about 425 miles of road now operated, and a combined capitalisation in stock and bonds, including that of all the subsidiary companies, of more than £108,000.

Exeter.—Mr. Domville had the following notice of motion on the agenda at the last City Council meeting : "That a committee be appointed to have charge of the electric light undertaking when acquired by the Council." He stated that the terms of the resolution did not altogether meet his views. What he wanted was a committee to confer with the electric light company and to watch over the interests of the Council He would move, with the permission of the Council : "That on the confirmation of the purchase of the electric light undertaking a new standing committee be appointed to take charge of the electric light undertaking and the lighting of the city generally, and that meanwhile a committee be appointed to confer with the electric light company on any question of the repair or renewal of any of the plant." Mr. Wreford seconded. Mr. Jarman thought the resolution was premature. A short time ago they decided to reduce the number of their committees, and now it was proposed to make an increase. He considered that it would be better to appoint a sub-committee from the present Lighting Committee to attend to this matter, and he moved an amendment to that effect The Town Clerk said if a sub committee were appointed it would have to report to the Standing Committee who would have to report to the Council. What was wanted was a committee with greater power. Mr. Varwell thought they should leave the control of the present undertaking to the discretion of the electric light company, and not interfere with a thing they knew very little about. Eventually it was decided to appoint the following special committee to confer with the electric light company on any question of repairs or the renewal of any plant : Aldermen Andrew, Peters, Houlditch and Domville, Councillors Ham. J Gidley, F J Williams Wreford, Peters, Fulford, Perry, Surridge, and Linscott

Bolton.—The Gas and Electricity Committee of the Corporation have discussed the question of lighting the intended new station for Bolton, and also the charges for the supply of electricity to large consumers. The price per unit is to remain at 6d., as before, with a discount of 10 per cent. for cash, and the following revised scale of special discounts was approved of, the net price per unit being as follows :

Consumption per quarter.	Special discount, per cent.	Net price per unit
Under 250 units	—	5 4d
Between 250 units and 500.....	2½	5 265d.
,, 500 ,, 750.....	6	5 13d.
,, 750 ,, 1,000.....	7½	4·995d.
,, 1,000 ,, 1,250.....	10	4 86d.
,, 1,250 ,, 1,500.....	12½	4 725d
,, 1,500 ,, 1,750.....	15	4·59d.
,, 1,750 ,, 2 000.....	17½	4 455d.
,, 2,000 ,, 2,250.....	20	4 32d.
,, 2,200 ,, 2,500.....	22½	4·185d.
Over 2,500 units	25	4 05d.

The railway company recently enquired what allowances the committee were prepared to make for the supply of electricity, and it was decided to furnish them with a copy of the revised scale. At the same meeting a letter was read from the secretary to the Board of Trade inviting the attendance of representatives from the Corporation at a meeting to be held in London on November 19, to consider the revised regulations and prices to be issued by the Board of Trade for the supply of electricity. The chairman (Alderman Miles, J P.) and the engineer (Mr. J. H. Rider, M I.E E.) were deputed to attend the meeting. The question of connecting the electricity works by telephone with the National Telephone Company was left to the chairman and vice chairman.

Douglas Southern Electric Tramways, Limited —This Company has been formed with a share capital of £50,000 and has acquired an exclusive concession for the construction and operation by the overhead wire system of an electric tramway upon the Douglas Head Marine Drive at Douglas, Isle of Man, upon the terms of paying to the Marine Drive Company one penny for each passenger entering upon the drive with a current tramway ticket. The capital is divided into 30,000 7 per cent. preference shares of £1 each, and 20,000 ordinary shares of £1 each. The present issue consists of 20,000 preference and 10,000 ordinary shares, the remainder being left unissued for future extension. The shares are offered at par, payable 5s. on application, 5s on allotment, and 10s. on December 1 next. The Douglas Head Marine Drive has been completed from the entrance gates on Douglas Head to Castletown-road, and work is being actively pushed forward upon the completion of the drive to near Port Soderick. The drive as completed is a fine boulevard, about 40ft. in width, running along the edge of the cliffs at a considerable height above the sea, and commands the finest marine views in the neighbourhood of Douglas. The concession is for a period of 10 years from April 2, 1895, at the expiration of which the Douglas Head Marine Drive, Limited (grantors of the concession), have the option of paying to the Company the sum of £30,000 for the first 2½ miles constructed, and a further sum at the rate of £10,000, or a proportionate part thereof, for every subsequent mile or part of a mile, or to extend the concession for a further period of 21 years upon agreed terms. The terms of the concession are such as to prohibit any other vehicles from taking up passengers upon the Marine Drive, and permit all holders of current tramway tickets to enter upon the drive free of charge to such holders. The great number of visitors that are annually attracted to the Isle of Man will be a constant source of revenue to the Company, and this number is increasing, being larger for the present year than for many years previous. It is confidently expected that most of the visitors will avail themselves of the opportunity which the tram system will afford of seeing the numerous places of interest.

Douglas (I.o.M.).—In consequence of the recent visit to London of the directors of the Manx Northern Railway Company, a rumour is circulated to the effect that the line had been sold. It is said that the purchasers are the Isle of Man Tramways Company, who have an electric system to Laxey from Douglas, the object being to extend the electric tramway from Laxey to Ramsey, to convert the present railway into an electric line, and connect Peel with Ramsey. No confirmation of the rumour is to hand. The Manx Legislative Council have considered the indenture of agreement between the Douglas Town Commissioners and the Tramways and Electric Power Company for a renewed lease of the bay tramways, and also a Bill to empower the construction of a cable tramway system by way of Prospect-hill to the upper part of the town The indenture provides that the company shall pay the Commissioners for the concession 15 per cent. of the gross yearly earnings of the bay tramway, the total sum not to amount to less than £1,500 any year, and further to construct a cable tramway to the upper part of the town and pay 5 per cent. of the gross earnings of the same after a lapse of seven years. Mr. Crippin appeared in person in opposition to the scheme and cross-examined witnesses to show that he had made a better offer than that of the company. The Commissioners' clerk replied to the effect that Mr. Crippin's offer had been considered by the Commissmissioners and not thought so good as that of the company. The Council only called for evidence to show that the tramway to the upper part of the town could be constructed without endangering the ordinary traffic, and were satisfied that the monetary consideration for the lease was sufficient. Deemster Drinkwater and the Clerk of the Rolls raised a strong objection to the tramway being laid on Prospect-hill, which is only 18ft. wide at its narrowest part, but on counsel for the Commissioners stating that it was the immediate intention of the Commissioners to widen the hill to 42ft. intimation was given by the Governor that the Council would confirm the indenture if the Commissioners would add a proviso to carry out the widening before May next, and the Council was adjourned in order that a proviso might be prepared and submitted. The lease to the tramway company is therefore as good as approved.

Electric Lighting in Calcutta.—It is quite refreshing to see that the Calcutta Commissioners have at length decided to give serious attention to this matter ; and that a call for fresh tenders for lighting the Harrison road has been recommended by the special committee engaged on this important subject. Several costly and unsatisfactory experiences have been gone through of late in such enterprise, and it behoves those concerned to guard against similar failures for the future, by the establishment of the best obtainable description of installation. That this cannot be procured at low first cost goes without saying; for the essence of success in these matters lies in a combination of highest qualities of machinery and plant, and that experience in erection and working which only an extensive first-class practice can afford. We are happy in noting the weight which the committee attach to the selection of conductors for the current ; for in the wise choice of the construction of these, and of the fashion in which they are laid, will indeed rest one main pillar of the edifice. Without a reliable system of distribution the best machinery would be useless ; and, as the percentage of cost falling to the mains is considerable, a most cautious choice and careful test of such cannot be too strongly recommended. We are somewhat surprised that the committee should have considered the possibility of using overhead lines, and that, apparently, they should have received some support in this from their expert. Far be it from us to condemn the aerial line in general ; for long unbranched main lines to distributional centres, suburban connections, and transmissions over country districts, nothing but overhead lines are at present economically imaginable ; but the installation of such in city thoroughfares cannot be too strongly condemned. With reference to the armoured and high-insulation resistance cable, which is now

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largely used in Europe, such cables are naturally expensive as regards first cost. This consideration is, however, more than outweighed by their great reliability and the low cost of upkeep and amortisation, ascertained in practice to be about 3 per cent. per annum on the value. We have one more remark to make concerning the choice of the system of lighting to be employed. In a number of places the endeavour has been made to successfully combine two or more systems (for instance, series arc—and alternate-current incandescent—lighting) under the impression that economy in working would be the result. We will not deny that, under certain rare circumstances, economy might be obtainable, but we should certainly deprecate any attempt of the kind in India, where success will be greatly dependent on the simplicity and uniformity of the control of and attendance to the generators and every other portion of the installation.—*Indian Engineer* of September 28.

New London Mains.—The report of the Highways Committee of the London County Council on Tuesday, stated that they had considered a notice, dated September 26, 1895, from the London Electric Supply Corporation of intention to lay low-tension distributing mains in Ebury-street, Victoria-square, and Buckingham Palace road. The mains will consist of rubber-insulated cable drawn into 3in. iron pipes, and are for a low-tension supply at 100 volts. They recommended that the sanction of the Council be given to the works. They also approved two further notices from the same company: (*a*) dated October 4, 1895, of intention to lay distributing mains in Grosvenor-mews, across Grosvenor street, Avery-row, South Molton lane and street, and Davies-street; (*b*) dated October 7, 1895, of intention to lay mains in Upper Russell-street and Lamb-lane. and a notice, dated September 25, 1895, from the Metropolitan Electric Supply Company of intention to lay mains in Elgin avenue and terrace, Portsdown-road, Canterbury-terrace, Maida-vale, Carlton vale and hill, Hamilton and Upper Hamilton terrace, Marlborough-place, Abbey road and gardens, Violet-hill, Abercorn-place, Nugent-terrace, Hill-road, Alma-square, Hamilton-gardens, Garden-road, Grove End-road, Hall-road, Circus-road, Elm Tree-road, Melina-place, Warwick-place, Sutherland-avenue, Amberley-road, Shirland-road, Warwick-road, Castellan-road, Formosa-street, Bristol-gardens, Clifton gardens, villas, and road, Warrington-crescent, Randolph-road, Portsdown-road, Lanark place and villas, Canterbury-terrace, Clarendon gardens and terrace, Edgware road, Maida hill West, Park-place-villas, Maida-vale, Compton-street, Campbell street, Howell-street, Cuthbert-street, Hethpool-street, Hall-place, Richmond-street, Lyons-place, Carlisle-street, Aberdeen-place, Northwich-terrace, St. John's Wood road, Hamilton-terrace, Cunningham-place, Warwick-place, Gloucester-terrace. A large part of the works referred to in this notice has been approved by the Council on previous notices of the company, but not carried out within the time specified in the notice of approval. The same company has also given a notice, dated October 7, 1895, of intention to lay mains in South-street Thayer-street, Mandeville-place, and James-street, and in Oxford street between James-street and Stratford-place. They further approved a notice dated September 30, 1895, from the County of London and Brush Provincial Electric Lighting Company of intention to lay pipes across High-street, Clapham, in two places; East-hill, High-street, and West-hill, Wandsworth, in two places; Upper Richmond road, in six places; High street, Putney, in two places; Putney-hill, in three places. Also a notice, dated October 9, 1895, from the Charing Cross and Strand Electricity Supply Corporation of intention to lay mains in Bull-inn-court, across and along the Strand, and in Salisbury-street. The proposed work is unobjectionable, but the committee think that the work in the Strand should be carried on by day and by night until completed. Also a notice, dated October 10, 1895, from the House-to-House Electric Light Supply Company of intention to lay low-tension mains, partly in 3in. pipes and partly in conduit, in Cranley-place and Onslow gardens and mews.

The Proposed Dorby-Ashbourne Electric Railway.—A meeting has been held to consider the proposed electric railway to Ashbourne from Derby, Mr. C. E. Newton, J.P., presiding. Mr. John Shaw, jun., explained the scheme. The railway was to be on the overhead system, and it was proposed that the line should be connected with the existing Derby tramway, which terminated on the Ashbourne-road, and thence it would run through Mackworth, Kirk Langley, and Brailsford, into the town of Ashbourne, terminating near the bridge. On only one portion of the line was there a really stiff grade, and that was for a mile at the Ashbourne end, but there was not any difficulty in getting over that. It was suggested that the line should be laid on the western side of the road through nearly the whole length, as there was ample room, but through the villages it would probably have to run down the centre There were telegraph poles placed at that side of the road, but there would not be any difficulty in obtaining power to remove them at a small cost. The permanent way could be laid at a cost of about £2,000 per mile. Paving would only be laid where absolutely required by the authorities. In all probability it would only be insisted upon through the villages, and a small portion at each end of the line—in Derby and Ashbourne. Electric signalling would be adopted to enable the crossings to be placed at as great a distance as possible from one another. Turn-outs and fixed stopping-places would be made where necessary, but a car could stop anywhere to take up or set down. The rolling-stock necessary for a line of that kind would consist of motor-cars, trailers, and goods cars. A motor car would have to be equipped with motors of 20 e.h.p. each. These cars would cost approximately about £600 each. Trailing cars, which would only be used in summer time, would cost about £200 each. The goods cars, specially fitted up, would cost about £100. All the cars would be lighted by electricity. It was proposed to build the generating station near the Brailsford Brook, about 7½ miles from Derby, as that seemed to be the best site, the heaviest part of the road being at the Ashbourne end. If sufficient hydraulic power could be obtained from the brook, a large saving might be made in generating the current. The following was a rough estimate showing the cost of the line: Cost of permanent way, including the cost of materials, laying, etc., £25,600; overhead equipment, £18,600; generating station, including land, buildings, engines, etc., £12,000; rolling-stock, including six motor cars, six trailing cars, and six goods cars, £6,100—total, £62,300. The maintenance of this line would be very small and the assistance it would be possible to give to the County and District Councils in delivering road materials would approximately pay for this. It was proposed to run the trains every hour probably, but at any rate as often as the traffic demanded. There would be depôts for goods, but not regular stations. The Great Northern Railway Company had decided to render them every assistance, and had agreed to allow them to run right into their goods yard; and the Electrical Construction Company had told him they would find a certain amount of money. They would, of course, invite tenders for the work. A resolution in favour of the railway was carried unanimously, and the Chairman said that the next matter was to have a certain amount of money subscribed, as he should like to see the £700 necessary to obtain an Act raised without having to go to any company.

Hampstead.—The Lighting Committee of the Vestry have recommended that a main for private lighting be laid down in Boundary-road, at a cost of £156. This was adopted. The same committee also recommended that the engineer be empowered to order 12 house-connection boxes, at a cost of £3. 16s. each. The recommendation was adopted. The committee recommended that the Willesden District Council be informed that, in consequence of the letter of their surveyor, the Vestry have again carefully considered the question of lighting the High-road, Kilburn, with electric light, and are strongly of the opinion that the arc lamps should be 24 in number, and placed on rests in the middle of the road; that by this arrangement the traffic would be regulated, rests at regular distances would be provided for the safety of the public, and the illuminating power of the lamps would be of the greatest efficiency; that the Vestry find (*a*) that the estimated cost of the 24 arc lamps, fixing, rests, and the cable connections to the Vestry's mains is £1,009. 4s., and (*b*) that the estimated cost of running these arc lamps is at the rate of £29. 13s. 6d. per arc lamp per annum; that the Vestry are willing to light the High-road, Kilburn, with electricity, on the condition that the Willesden District Council pay half the cost of the installation (*a*), and half the cost of running the lamps (*b*). The motion was carried. The same committee recommended that Mr. Bateman, of Finchley-road, be informed that the Vestry will grant him permission to light his outside lamp with electric light, provided he will take the supply of electricity from the Vestry, and sign the usual agreement. The recommendation was adopted. The committee recommended that the application of the three assistant electrical engineers at the central station for an increase in their salaries be not entertained. Mr. Johnson suggested that the application should be considered at the usual time for such applications to be sent in—viz, in January. The recommendation was adopted. Mr. Thwaites said that at the present time there was an equivalent of 17,000 8-c.p. lamps fixed in the premises of the Vestry's private customers, and now they had applications in hand for over 3,000 more. Mr. Johnson asked if the engineer could tell the Vestry what was the amount of the loss of electrical current between the quantity produced at the central station and that consumed by the customers The Chairman: Notice should have been given of such a question. Shortly afterwards Mr. Johnson, pursuant to notice, rose "to draw the attention of the Vestry to the absence from the recommendations of the Lighting Committee of any proposals to extend the public lighting by means of the electric current, and to request them to report thereon." He said that, had his question been answered, there would have been no need for this motion. He was informed, however, that the loss of current was as much as 66 per cent., and, if that were so, they could well understand why the Lighting Committee had not brought forward any proposals for the extension of the public lighting. He had been told by a man who ought to know that where the electric light was used in the streets the shopkeepers were bound for self-protection to have it inside their shops. Mr. Boyce seconded. Major-General Young said there was nothing in this proposal. There was already a resolution of the Vestry that only three roads were to be lighted by electricity at present—the Finchley-road, High-road, and Haverstock hill and High-street. Finchley-road was lighted by electricity, the proposal to light the High-road had been discussed that evening, so that there only remained one other of these thoroughfares It might be asked, "Why don't you go on with this?" Well, it was in the hands of the Lighting Committee, and they had better leave it there. Only four voted for the motion, which was lost.

Brandon and Byshottles (Durham).—The Chairman said at the last meeting of the Urban District Council that at the previous meeting they had before them the estimates of the Corlett Electrical Engineering Company, but lack of time then prevented the consideration requisite for so important a subject. He had since had the opportunity of looking through the estimates, and that perusal had confirmed him as to the practicability of the views put forward by him at the last meeting on the subject. In the East Ward the North Brancepeth Coal Company had made an offer by which the Council would merely be charged a sum to clear actual attendance and lubrication of the requisite

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machinery for producing the electric light. He hoped they would be as successful in the other wards. He counselled them to go very carefully into the figures which would be submitted to them and see what the proposal meant to the district, and whether economically electricity was to be preferred to gas, and so forth. The Clerk said any decision that the Council could come to that day would only refer to the main thoroughfares, and nothing else whatever. If they decided to light the district by electricity, and also to light private streets and private premises, they would have a considerable amount of further procedure to go through before they were in a position to assume these powers. They would have to apply to the Board of Trade for a license or secure an Act of Parliament. A Board of Trade license only lasted for seven years. and there were considerable formalities to go through. The Chairman then furnished the Board with certain figures relating to the project. It was proposed in the East Ward to erect 74 lamps for the illumination of the public thoroughfares in that ward. Seventy-four gas lamps complete at £3 per lamp totalled £222, that being within the Durham Gas Company's estimate. The cost per annum of each lamp, to be lighted at dark and extinguished at 12 p.m., was about £1. 17s, making a total for the 74 lamps of £136 18s. Lighting and repairs was estimated at about 6s. 6d. per lamp — total, £24. 1s. The total amount required to clear the cost of the first year's lighting by gas was therefore £382 19s The estimate for 74 electric lights for the same ward was as follows : An 85-light dynamo, with engine, lamps, and everything complete £444. The cost for running per annum, £60, making a total of £500. Comparing the cost the first year as between gas and electricity, there was a difference of considerably over £100 in favour of gas But in subsequent years electricity would only cost them £60 per annum, hence the Council could easily see the advantage of electricity over gas If electricity were adopted, the Council would in three years recoup itself for the extra initial cost of plant. The Chairman said for the centre ward there was only one scheme submitted, and that was for lighting it with the electric light. It was proposed to erect 18 lamps. The cost of the necessary plant (including a dynamo for 85 lights) and 18 posts, fittings, etc., was £269 The cost of running would be £75. 2s. per annum. At this point an estimate for providing the necessary plant for lighting the East Ward with electricity was read from Messrs Ernest Scott, Mountain, and Co , of Newcastle They would provide an installation to maintain 50 lamps, each of 32 c p., for £480. On the motion of Mr. Willis, seconded by Mr Barnes, it was unanimously resolved, "That the main roads and main streets in this Council's district be lighted by electricity. subject to satisfactory estimates as to the cost being obtained, and subject to license of Board of Trade being obtained if necessary. That the surveyor, in conjunction with the Works Committee and Councillor Green, be instructed to prepare plans as to the proposed scheme for lighting the main roads and streets in the Council's district. That advertisements be inserted in the three Newcastle papers and in the two Durham papers, inviting tenders for provision of electric lighting in accordance with the particulars to be prepared by the surveyor and the Works Committee."

Hanley.—Mr. G. W. Willcocks, M I C.E , Local Government Board inspector, held an enquiry at the Town Hall, Hanley, on the 16th inst for the purpose of investigating an application by the Hanley Town Council for permission to borrow the sum of £20,000 for the purpose of extending the electric light works and mains. The Town Council was represented by Aldermen E. J Hammersley (mayor), J. Shirley (chairman of General Purposes and Electric Light Committee), T. Hampton, Councillors W. O'Keeffe, M. Huntbach, J. H. Ball, J Turner, T. Pickin, A. Wood, J. Goodson, M. Tunnicliffe, and A P. Miller, and A. Challinor (town clerk), J. Lobley, M.I.C.E. (borough engineer and surveyor), C. A. Cowell and C. J. Sutherland (electrical engineers and joint managers of electricity works) The enquiry was opened by the Town Clerk, who stated that the population of the borough was estimated at 56,000, and that the assessable value was £182,238, with an outstanding debt of £195,460. Included in that debt was £30,000 for electric lighting—namely, £21,000 for works and mains £1,000 for meters, etc., £3,000 for wiring all the Corporation buildings, and £5,000 for additional 300-kilowatt steam alternator and condensing apparatus. The present application was not opposed. It was made under the Electric Lighting Act, 1887, Section 8, and the purpose of the proposed loan was to extend the buildings, boiler plant, and switchboard required for the new alternator, and to extend the mains in different parts of the town. So far the Corporation had limited the supply of energy to consumers within the compulsory area. The demand for light was increasing continually, and was so great that although the markets were wired and fitted up it was not considered safe to connect them with the mains until further generating plant was provided. The result of the first six months' working ending December 31 last was that £31 was realised over the working expenses, and interest and sinking fund. The borough engineer and surveyor, and the Corporation electrical engineer, presented a report, which was unanimously approved at a Council held on April 30 last, and of which the following is a summary : (No. 1) Extension of mains to Market, Bath, Hope, Clough Charles, Trinity, Stafford, Tontine, Jasper, Bethesda, and Broad streets, Etruria, Regent, Hope, Victoria, Avenue, and Park roads, Piccadilly, Pall Mall, Birch-terrace, Snow-hill, and Park-avenue. These include high and low pressure mains, and for a second circuit of 30 arc lamps. The estimate for the above cables, including laying, is £5,508. (No. 2) Extension of the buildings at the generating station (leaving room for an additional boiler, condenser, and steam alternator when the same are required). Two new boilers and appurtenances, 16 sub-stations, 20 transformers, 25 junction-boxes, and 30 arc lamps and posts. The estimate for No. 2 list is £5,900. (No. 3) Two Ferranti rectifiers for both the present circuit of 30 arc lamps and for the new circuit, the present arc dynamos and engines being retained as reserve ; also 30 incandescent street lamps complete on new roads round the park, and 60 ditto in other parts of the town where mains are being laid ; extension of switchboards, and excavations and railings at works. The estimate for No. 3 list is £1 242 (No. 4) In consequence of the demand for energy within the compulsory area, considerable extensions have been made to the machinery, mains, sub stations, and transformers, amounting to £2,650, and to the buildings, furniture, excavating, drainage, and formation of ground, amounting to £2,060 ; sundries, £200 ; total for No. 4, £4,850. (No. 5) Provision for contingencies £1 000, special regard being to mains being laid to supply manufacturers with motive power. (No. 6) Meters and switches provided on consumers' premises, for which rental is paid ; estimate £1,500, including £250 already expended. Total for present application, £20,000. Mr. Lobley gave a detailed explanation of the purposes for which the money was needed, and Messrs. Cowell and Sutherland showed the increase in the number of lamps connected, which was considerably above the present capacity of the generating plant—namely, 10,000 8-c p. lamps The enquiry then terminated, and the inspector subsequently visited the works and proposed new lines of mains and arc lamps.

The Brighton and Rottingdean Seashore Electric Tramway. We have often referred to the progress of this interesting undertaking. A correspondent of the *Daily News* writes : From the Aquarium to Kemp Town a little electric railway, designed and carried out by Mr. Magnus Volk, has been running for some years It runs along the beach above high-water mark in some places, and on trestle bridges in others. The force is supplied by an engine and dynamo at the Kemp Town end. and conveyed along the line by a third line. The railway to Kemp Town has been a financial success, and gives a very efficient service, but the plan is obviously not one which could be repeated on a bigger scale. It certainly could not be extended to Rottingdean. In the three miles between the terminus of the existing electric railway and Rottingdean, there is practically no beach which is not covered at high tide. To construct a long viaduct would have been too expensive, and when a gale is blowing from the southward no viaduct would have been very safe The ups and downs on the cliff top made a railway by that route also a somewhat serious undertaking. But Mr. Volk was determined to run an electric railway eastwards to Rottingdean. In his necessity he hit upon an entirely novel idea. He would run his railway on the foreshore, slightly above low water mark, and 14ft. below the sea at its high-water level. His railway carriage would be a long legged thing running on lines which for the greater part of the 24 hours would be beneath the water. His stations at each end would be piers. Mr. Volk went to Parliament for powers and in 1893 an Act was passed authorising the construction of a tramway with a gauge not exceeding 24ft , to be worked by electricity between Brighton and Rottingdean. By the May of 1894 he was at work, and by next Easter he hopes to open the line for traffic In order to give stability to so tall a carriage running through a sea not free from tidal currents a broad base was necessary. At first Mr. Volk thought two rails 24ft. apart would be enough, but the expansion and contraction of tie-rods 24ft. long would have been considerable. Instead, therefore, of two rails connected by tie rods, the line has been constructed with four parallel rails, running in pairs. The breadth of gauge between the outer rails is 18ft. Each pair of rails is constructed and laid separately. The car will run on all four rails, each pair of rails serving the purpose of a single rail on an ordinary line. Each pair of rails is supported by concrete blocks mortised to the rock below. When the railway was designed and begun the rock was covered with sand to a depth in some places of 7ft., and the mortising of the blocks to the rock was naturally made much more difficult by the necessity of clearing away the running sand in the brief working day of two or three hours while the tide was far enough out to render work possible. During the storms of last winter, however, the whole stretch of coast was for the first time in the memory of man denuded of sand. The sand is now slowly being replaced by the sea on the shore which the storm laid bare It speaks well for the strength of the permanent way that no part of it was in the least injured by the storms. The concrete blocks were all made on the spot, and the work was done under such conditions of haste that the materials often could not be cleared away before the tide came. All but 400 yards of the permanent way has now been completed. The steepest gradient is 1 in 300, and the sharpest curve a radius of half a mile. The car, which was designed by Mr. St. George Moore, 17, Victoria-street, Westminster, who acts as engineer to the company jointly with Mr. Volk, is built by the Gloucester Wagon Company, and is specially adapted to the four rails. Each of its four main supports is a 12in. steel tube running on a four-wheeled bogie. There will thus be 16 wheels. The leading bogies will be driven by vertical shafts inside the steel tubes. The deck of the car is to be 23ft. high, and thus well out of the reach of any ordinary waves. The deck will measure 46ft. by 22ft., and will carry a saloon measuring 25ft. by 13ft. It is expected that some 100 to 150 passengers may find room in the single car. The railway will start working with one car only, but another will doubtless be added, with any improvements which practical experience may suggest. It was at first intended that the motive power, which will be supplied by a large Crossley gas-engine worked by producer gas housed in an engine-room excavated in the cliff at the Brighton end, should be conveyed by accumulators on the car itself. No power, therefore, was taken in the Act of Parliament for the

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erection of poles. It, however, became clear that, to make the undertaking a commercial success, the electricity must be carried by wires and that poles must be laid along the foreshore for this purpose. The Board of Trade, who administer of behalf of the Crown the greater part of the foreshore, readily gave their consent to the erection of poles, charging a nominal rent of £1 a year in addition to the £12. 10s. which they receive for the permanent way. The tramway company are now awaiting a similar consent from the Brighton Corporation, who own one-sixth of the three miles of foreshore. Some members of the Corporation fear that the poles will be unsightly. If the Corporation refuse their consent, the company must go again to Parliament. The company, who have done the work without the intervention of a contractor, believe that the total cost of the line will not much exceed the £25,000 which they obtained power to raise.

PROVISIONAL PATENTS, 1895.

OCTOBER 14.

19245. **Improvements in dynamo-electric generators and motors.** Reginald Wood, 28, Southampton-buildings, Chancery-lane, London.

19256. **An improved electricity meter for registering the amount of current consumed on direct or alternating polyphase, triphase, or quadruplephase circuits.** Frederick John Beaumont and Frederick Hallows, 166, Fleet street, London.

19260. **Improved electrical apparatus for preventing the collision of railway trains.** Julius Ernest Florea and Alexander Olteanu, 45, Southampton-buildings, Chancery-lane, London.

19272. **Improvements in or relating to the steering of electric or steam carriages, cycles, bath chairs, or other like vehicles.** Edwin Ruck Kesterton, 14, Nightingale-lane, Balham, London.

OCTOBER 15.

19275. **Improvements in electric incandescent glow lamps.** Reuben James Bott, 9, Park-place-villas, St. Mary's, Paddington, London.

19304. **Improvements in phosphorescent electric lighting.** William Lloyd Wise, 46, Lincoln's inn-fields, London. (The Moore Electrical Company, United States.) (Complete specification.)

19317. **Electric railways.** John La Burt, 321, High Holborn, London. (Complete specification)

19318. **Improvements in combined telephone and signalling systems.** James Gilmore Smith and Robert Grey Vassar, 52, Chancery-lane, London (Complete specification)

19337. **An improved means for connecting the filament in incandescent lamps with the source of current.** William Phillips Thompson, 6, Lord-street, Liverpool. (The Phönix Süddeutsche Glühlampefabrik Gesellschaft mit beschränkter Haftung, Germany).

19340. **Improvements relating to electric cars.** Percy William Thomas Davies, 31, High Holborn, London.

19353. **Improvements in electric gas-lighting apparatus.** Jean Jahnsson, 323, High Holborn, London.

19374. **Improvements in incandescent electric lamps and the method of making the same** Samuel Edward Cox, 18, Buckingham-street, Strand, London. (Complete specification.)

OCTOBER 16.

19380. **Improvements in the manufacture of insulated cables.** George Hinde Nisbett, 8, Quality-court, Chancery-lane, London. (Complete specification)

19389. **Improvements in tempering the wire points of textile cards electrically, and in apparatus therefor.** Charles Brooke Crawshaw and Rankin Kennedy, Hubert-street, Leeds-road, Bradford.

19402. **Improvements in and connected with return circuits for electric railways and tramways.** William Edwin Hayes, 70, Market-street, Manchester. (Gisbert Kapp, Germany.)

19442. **An improved method of and apparatus for welding by electricity and for other purposes.** Albert Hirsch, 53, Chancery-lane, London.

19461. **Improvements in thermo-electric generators.** Harry Barringer Cox, 46, Lincoln's-inn-fields, London. (Complete specification.)

OCTOBER 17.

19503. **Improvements in telephonic apparatus.** Charles Adams-Randall, 1, The Avenue, Bedford-park, London.

19509. **Improvements in alternating electric current transformers.** John Alexander McMullen, 124, Chancery-lane, London.

19527. **Improvements in high-insulation fuses or cut-outs for electric lighting.** John Mackenzie Urquhart and William Henry Dingle, 23, Bucklersbury, London.

OCTOBER 18.

19551. **An improvement in conduits for conductors of electricity or other mains.** William Douglas Reid, 25, Criffel-avenue, Streatham-hill, London.

19577. **Improvements in incandescent electric lampholders.** Parker Lindsay and John Bradin, 70, Wellington-street, Glasgow.

19605. **Improvements in and connected with dynamos and the driving of same and electric motors for the driving of vehicles and machinery.** John Vaughan Sherrin, 77, Chancery-lane, London.

OCTOBER 19.

19647. **Improvements in secondary batteries.** William Henry Willatt, 22, Jalland-street, Holderness-road, Hull.

19669. **Improvements in secondary battery plates.** Alexander Schanschieff, 77, Chancery-lane, London.

19670. **Improvements in secondary batteries.** Alexander Schanschieff 77, Chancery-lane, London.

19696 **Improvement in electric light display systems.** Jonathan Edwards Woodbridge, 33, Chancery-lane, London. (Date applied for under Patents, etc., Act. 1883, Sec. 103, July 8, 1895, being date of application in United States.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1894.

12483. **Electric batteries.** Shrewsbury and others.
18328 **Telegraphy.** Fletcher.
19184. **Electric heaters.** Davis.
19220 **Electric ship logs, etc.** Whyte and Muirhead.
22819. **Lock and block electric apparatus for railways.** Tyer.
22973. **Storage batteries.** Brown.

1895.

7782 **Electric resistances.** Voigt and Haeffner.
12329. **Telegraphic systems** Merrel and Duffek.
13405 **Electric telephone systems** Marr.
14492. **Electric lamps.** Prieto.
15365. **Electric switches** Dingle and Urquhart.
15513 **Dynamo-electric machines.** Doney.
15886. **Electric batteries.** Wollaston.
16008. **Telephonic instrument.** Dillberg and Rabbidge.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¾-6¼
Brush Company, Ordinary	3	1¼-1½
—— Non. Cum , 6 per cent. Pref.	2	2-2¼
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5¼-5¾
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6¾-7¼
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	133-137
City and South London Railway, Consolidated Ordinary	100	38-40
—— 4 per cent. Debenture Stock	100	134-136
—— 5 per cent. Pref. Shares	10	14¼-15½
County of London and Brush Provincial Co., Ordinary	10	8¼-9¼
—— 6 per cent. Cum. Pref.	6	8¾-9¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅝-¾
—— 6 per cent. Debentures	—	95-100
—— 7 per cent. Cumulative Pref.	2	2-2¼
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	1-1⅛
Fowler-Waring Cables	5	¼-⅜
W. T. Henley's Telegraph Works, Ordinary	10	14¼-14¾
—— 7 per cent. Preference	10	15¾-16¼
—— 4½ per cent. Debentures	100	107-110
House-to-House Company, Ordinary	5	4-4¼
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	19-20
—— 4½ per cent. Debentures	100	100-102
Kensington and Knightsbridge Ordinary	5	8-8¼
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅞-8⅛
Liverpool Overhead Railway	10	11¾-11⅞
—— 5 per cent. Pref.	10	15-15½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric Supply	5	⅜-½
Metropolitan Electric Supply	10	11¼-11⅜
—— 4½ per cent. First Mortgage Debenture Stock	100	117-119
National Telephone, Ordinary	5	6¼-6⅜
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15-16
—— 5 per cent. Non. Cum. Third Pref.	5	6¼-6½
—— 3½ per cent. Deb. Stock	100	106-108
Notting Hill Company	10	8¼-9½
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7¼-7½
—— £4½ shares	4½	6¼-6¾
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-106
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8¼-8
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4¼-4¾
Westminster Electric Supply, Ordinary	5	8¾-9
Yorkshire House-to-House	5	6¾-7

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NOTES.

The Tesla Polyphase Patents.—The General Electric Company has been granted more time—viz., until November 16—to file evidence in the suit of the Westinghouse Company against it for infringement of the Tesla patents; and the plaintiffs have 20 days thereafter for cross-examination. The original limit was October 7.

Electrotherapy in France.—The Municipality of Paris having granted 20,000f. for the purpose, new buildings are to be erected at the Salpétrière Hospital for the treatment of nervous and mental affections by electricity, the ward in which the late Dr. Charcot applied the treatment being inadequate for the number of patients.

"Superseding Telegraphy."—The latest Yankee crank is a Mr. Hawkins, said to be a well-known banker and amateur scientist, who proposes to supersede the Transatlantic telegraph "by using the moon as a sort of reflector, and sending an intermittent beam of light from a powerful mirror to the dark surface of the moon, which will then be seen from the other side of the earth." "Fears" are expressed that it may be difficult to make the mirrors large enough!

Electric Carriages on the Stage.—We had the pleasure of seeing yesterday, just before going to press, a four-seated electric carriage, apparently on the Jeantaud system, which Sir Augustus Harris, we are informed, purposes introducing on the stage in his forthcoming pantomime of "Cinderella." As an anachronism, Cinderella in an electric carriage reminds one of the electric incandescent lamps which illumined Jonah's parlour in the whale's interior, as shown in a New York drama.

Electricity at the Brussels University.—The electrical and anatomical institutes founded by M. Ernest Solvay and presented by him and other donors to the University of Brussels have been officially inaugurated under the presidency of the Burgomaster, assisted by M. Graux, the Chancellor, and the entire body of professors. Delegations from the English and Continental universities responded to the invitation of the Brussels University to take part in the series of *fêtes* organised in celebration of the event.

Electrical Conductivity near the Critical Temperature.—Signor Adolfo Bartoli has repeated and confirmed his earlier observations on the electrical conductivity of liquids and gases near the critical temperature, using slightly modified apparatus. Pure benzene has no conductivity either in the liquid or gaseous state—that is, just below and just above the critical temperature. Methylic alcohol and sulphurous anhydride, however, conduct slightly when liquid just below the critical temperature, but lose this feeble conductivity when gaseous just above that temperature.

Peculiar Electric Lamp.—Dr. Aron has devised a peculiar electric lamp which is very useful for special optical experiments. The current is taken between two quantities of mercury, each in one limb of an inverted U-tube, exhausted of air, and the lamp is started by sloping it until there is for a moment a continuity between the two quantities of mercury. Thereafter, the discharge is continuous, and the light produced is of an intense greenish white, but its spectrum is limited to a very few lines, those of mercury, and this enables optical measurements to be effected with great accuracy.

Water Power in Wales.—In the current number of the *Geninen*, the national Welsh quarterly, Mr. Benjamin Davies, of University College, Liverpool, has an interesting article on water power in Wales, in which he comments upon the extravagance of wasting such mechanical power. Were the people, he says, to get the land under their own control, much could be done straight away. "Groups of farmers might join in placing a dynamo electric machine at the riverside, which would supply them at their respective farms, free of cost, with an unlimited supply of power for threshing, winnowing, driving creameries, etc."

The Physical Society.—An ordinary meeting of the Physical Society was held on October 25, Mr. Walter Baily, vice-president, in the chair. Prof. J. Perry read a paper by himself and Mr. H. F. Hunt on "A Method for the Development of Arbitrary Functions," which is an improvement on that described by him during the discussion of Prof. Henrici's paper of April 13 last. Only a planimeter and pencil and paper were required. Mr. F. W. Lanchester read a paper on the "Radial Cursor,' which is a new addition to the slide rule, enabling fractional indices to be dealt with, and which would be useful in problems involving, for example, the adiabatic expansion of a gas.

Lighting by Luminescence.—In a paper read by M. A. Witz before the Académie des Sciences, the author gives the results of his attempts to measure the quantity of energy necessary to illuminate Geissler tubes. The figures that he has obtained show that in lighting by luminescence the proportion of calorific energy as compared with the total energy is feebler than in any other luminous source. The author thinks that by reducing the losses of electricity to a minimum, by concentrating the light in a confined space, by utilising the fluorescence of certain substances, and, finally, by devising certain special arrangements, one may hope to obtain luminous sources whose photogenic rendering will be superior to the best now known.

The Institute of France.—At the centenary banquet of the Institute of France the other evening, Lord Kelvin, after reading an address of good wishes from the Royal Society of London, spoke of the honour which he felt in being an associate, and of the still greater debt which he owed to France as the true *alma mater* of his scientific youth, the inspirer of that admiration for the beauty of science which had made him its lifelong servant. Laplace initiated him in the *mécanique céleste*, and a little later the venerable Biot, taking him by the hand, placed him in Regnault's laboratory. He was ever grateful to Regnault and Liouville for their thorough teaching in 1845 in experimental and mathematical physics. Dr. Frankland then proposed the toast of "France," and many telegrams of congratulation were read from foreign bodies, including the St. Petersburg Academy of Sciences.

The Berlin Exhibition of 1896.—The executive of the forthcoming industrial exhibition in Berlin have come to an extraordinary decision. They have resolved that the exhibition buildings proper should only be opened while daylight lasted, this decision being based on grounds of economy. It was estimated that the electric lighting of the buildings would entail an extra expenditure of 400,000 marks (£20,000), and the majority of the committee were of opinion that for this and other minor reasons the lighting should be dispensed with. On the other hand, it was argued that the increased number of visitors would counterbalance this expense. It must be remembered, moreover, that the restaurants and other buildings in the grounds of the exhibition are to remain open until midnight. The resolution is meeting with considerable opposition, and it is not improbable that it may yet be rescinded.

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Electricity and Sprinting.—In running sprint races it is very important to save even the fifth of a second. It has been proved by experiment that the time which elapses between the firing of the starter's pistol and the actual starting of the runner is long enough to influence the winning of a race. An arrangement for measuring a runner's reaction time down to the thousandth of a second has, it is said, been contrived in the Yale laboratory. The starter's pistol is arranged so that an electric contact is broken when the pistol goes off. A thread is attached to the right foot of the runner. This thread breaks an electric contact the moment the runner starts. Each of these electric contacts makes a spark on a smoked cylinder in such a way that the time which has elapsed between the first contact and the second can be measured.

Angling by Electric Light.—Last Saturday night two anglers, one a resident of Newhaven, tried the interesting experiment of fishing in Seaford Bay by electric light. A fisherman of Newhaven rowed the anglers from the Railway Pier soon after six o'clock, when it was completely dark. A portable battery with a 5-c.p. incandescent lamp was taken, and this lamp was lowered until a weight below it touched the bottom at 25ft. Both battery and lamp were specially made for the trial, and the lamp was protected by a galvanised crinoline and was made watertight. When it reached the bottom of the sea there was, it is stated, a circular area, 20 yards in diameter, brightly illuminated right up to the surface. Fishing was carried on with an ordinary line on the port side, the lamp having been lowered on the starboard side of the boat. A successful result followed the experiment, and a splendid dish of whiting was caught.

The Application of the Alternating Current to Railway Work.—An American contemporary says: "We have already chronicled a number of instances of the application of the three-phase system to the covering of long railway lines. It is evidently now only a question of time when the alternating current will be applied directly to the motor on the car. That the large manufacturing companies are alive to the situation is evidenced by the experiments in this direction which we are informed are now being actively prosecuted, and we know that a direct application of the alternating motor to a road about to be equipped is seriously under consideration by its engineers. To be sure, the two wires required for its overhead work will militate against the introduction of the alternating system in cities, but for interurban roads which are now rapidly increasing, and which are practically free from the danger of crosses from overhead wires, there appears to be no valid objection to the use of two wires.

Electricity at the Brighton Carnival.—Not the least interesting feature in connection with the recent carnival at Brighton, a correspondent writes, was the use of the electric searchlight from the top of the great chimney shaft now in course of erection at the Corporation electricity generating station in North-road. Mr. Wright, the superintendent of the works, had caused two very powerful lights to be fixed on the summit of the new shaft, which is 200ft. high. It was estimated that the light was of nearly a million candle-power, and that it could be seen 60 miles off. The current was conveyed to the lights by wires from the generating station. Members of the electrical staff manipulated the apparatus, which was lent specially for the occasion by Messrs. Crompton and Co. and Messrs. Johnson and Phillips. When the light was first turned, on the atmosphere was somewhat hazy, but it afterwards became clearer, and the brilliant light was alternately thrown over various parts of the town, and aroused the interest and admiration of the thousands who thronged the streets.

The Pacific Cable Scheme.—At the invitation of Sir Charles Tupper, a meeting was held at the office of the High Commissioner for Canada on Tuesday to discuss the Pacific cable scheme. In addition to the High Commissioner for Canada, there were present the representatives of the Australasian and South African Colonies. The instructions sent by the various Colonial Governments to their representatives were discussed, in view of the probable forthcoming conference with the Secretary of State. It is announced that the Colonies, being quite prepared substantially to support the scheme, are desirous that the question should no longer remain in abeyance. The question of a fast Transatlantic service will not be discussed for the moment, but the negotiations bear more directly upon the cable scheme proper. It is added that the reported granting of a concession for an exclusive American cable between the United States and the Hawaiian group will probably necessitate the landing of the British cable on another Pacific island at a higher cost. The date of the conference with Mr. Chamberlain will not be fixed until the return to London of the Secretary of State.

Electrical Progress in Australia.—The Chief Railway Commissioner of New South Wales has furnished a number of interesting details in connection with the improvements which the Railway Commissioners are desirous of introducing into the Sydney tramway system. What strongly impressed him in his recent tour in Europe, he says, was the great development of electricity for tramway purposes. The overhead system was almost universally adopted, engineers having divested it of most of the objectionable features which had previously tended to disfigure the streets. As the outcome of the congested state of the traffic in Elizabeth-street, which is the sole artery for all the tram lines radiating from the city, the Commissioners will approach the Government with the view to securing authority for the construction of tram lines along Pitt and George streets. The motive power will in all probability be supplied by electricity applied on the conduit system in the busier portion of the streets, and, beyond such limits, on the overhead system. Ultimately, the Commissioners hope to be able to entirely supersede steam by electricity on the whole of the tramways, as it is thoroughly efficient, and will in their opinion answer admirably for sharp curves and steep gradients, which occur within the metropolitan areas served by the tramways.

Indiarubber.—As supplementing the note under this head which appeared in our last issue (p. 468), we note that the *Kew Bulletin* of miscellaneous information for the month of October gives some details concerning the new rubber industry in Lagos. It states that there was started at the Gold Coast by Sir Alfred Moloney in 1882 a rubber industry, which by 1893 had attained to the annual value of £200,000. In 1882 Sir Alfred Moloney addressed a letter to the *Lagos Times* strongly recommending attention to the possibilities of a similar industry in Lagos, and suggesting "the adoption of measures having for their object the addition of one more to the industries of the colony." The result of this letter was not immediately apparent; but in 1894 the present Governor of Lagos, Sir Gilbert T. Carter, announced that he had been able to induce a party of natives from the Gold Coast experienced in rubber collecting to go to Lagos with a view to the development of this valuable and important industry. A trade in rubber was thus established at Lagos, and a table is appended showing that the industry underwent a remarkable development during the first six months of the present year, the amount of rubber exported rising from 21,131lb, of the value of £1,213. 10s. 3d., in January to 268,619lb., of the value of

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£12,577. 2s. 6d., in June, the total for the six months being 588,633lb., of the value of £29,765. 18s. 5d. The *Bulletin* adds: "The history of this new rubber industry in Lagos is full of interest, and illustrates the wonderfully rich resources of the vast forests of West Africa. It shows also very clearly how largely these resources can be developed by judicious and intelligent action on the part of the Government."

The Development of Electric Traction.—The developments of the year in electric traction circles, the *Electrical Review* of New York says, have been very gratifying to all connected with the street railway business, and the future is full of promise. For these reasons, as well as others, the annual meeting of the American Street Railway Association, which is in session this week at Montreal, should be a very successful one. Great strides have been made during the past few months in adapting the electric motor to various conditions and requirements of passenger traffic. We have seen old and conservative steam railways forced to give in to the competition of trolley roads, and in self-defence adopt electrical equipment for short local lines. The electrical installations on the Nantasket Beach line of the New York, New Haven, and Hartford Railroad, and the Mount Holly branch of the Pennsylvania Railroad have been proved to be successful, and a new era in combined steam and electric railroading is inaugurated. The big electric locomotive in the Baltimore and Ohio Railroad's belt line tunnel at Baltimore has amply demonstrated its ability to outclass any steam locomotive as a traction motor for the purposes and conditions it was designed to fulfil. The underground trolley lines on Lenox-avenue in New York City, and in Washington, D.C., have been perfectly successful up to date, and bid fair to supersede the cable railway almost entirely. We are promised an electric storage battery surface line in New York City, of which great things are expected. The new cable lines in New York have taken away so much of the traffic of the elevated railways as to oblige this unaccommodating corporation to follow in the footsteps of other steam roads and adopt an electrical equipment, or else be forced to the wall. Besides all these good things, the journal adds, electric railway apparatus has been steadily improved, as have also methods of operation and management.

The Progress of Electricity in Canada.—Mr. George Johnson, the statistician of the Dominion Government, has published some interesting data regarding the progress and present status of the electric railways, telegraphs, etc., of Canada. The present value of the electric railways, telegraphs, etc., of the Dominion is given by Mr. Johnson as follows:

Telegraphs and cables	$7,000,000
Railways	13,000,000
Telephones	1,000,000
Electric light works	6,000,000
	$27,000,000

The first cable laid in Canada was between Prince Edward Island and the mainland, and was put down in 1852. The cable between Cape Breton and Newfoundland was laid in 1856. The telephones of Canada have 44,000 miles of wire and 35,000 instruments. The Dominion Government own 238 miles of telegraph cable line, the total mileage of their land lines being 2,500. There were in 1891 80 electric light works in Canada, with a capital of 4,113,771dol., employing 763 hands, and paying annual wages of 297,700dol. The annual value of output was 1,154,150dol. The previous census of 1881 showed only two hands as being employed in electric works. There were at the end of 1894 368 miles of electric railway in Canada, making 73 miles to each million of people. There were 658 motor cars, 341 trailers, 39 snow-sweepers, and 891 motors. In 1894 the number of miles run was 15,587,226, and the passengers carried 55,348,612. The different electric railway companies had 2,614 employés and a paid-up capital of 13,035,263dol. In 1893 there were only 256 miles of electric railway, the increase for the year being 112 miles. Every province now has electric railways except Prince Edward Island. To show the progress and present position of electric railways in Canada, as compared with other countries, the following table is given:

	Miles in operation.	Cars.
Europe	434	1,236
Germany	227	632
France	60	152
Austria-Hungary	28	129

The steam railways of Canada carried in 1894 14,500,000 passengers, or only about one-fourth of the number of the electric railways. If the patronage of electric roads had been equally distributed, each person in Canada would have been carried 12 times by electricity.

The Blackening of Incandescent Lamps.—Signor G. Tolomei has recently published an article wherein he gives the result of the microscopic examination which he made of filaments of incandescent lamps, before and after use. By the same means he also studied the pellicle deposited upon the glass. The instrument employed by the experimenter magnified 850 times. A filament not yet used presents a regularly undulating surface; on the other hand, the filament of a lamp out of use is covered with minute protuberances resembling in miniature those of arc carbons. The protuberances appear to have been produced by molten matter. Near the points of rupture and often elsewhere the filament seems to the naked eye to be covered with lampblack; in these places, and especially near the rupture, it appears, under the microscope, furrowed with transverse cavities, like craters, from which spring ramifications of lampblack, which have the appearance of volcanic jets. The examination of a pellicle of a blackened globe shows that the deposit is much thicker opposite the point of rupture than elsewhere. This, according to the author, indicates that the cause of the rupture is the same as that which produces the blackening of the glass, and that it is in relation to the development of a gas proceeding from the filament. The theory according to which the blackening would result from a chemical change of charcoal by an oxide of residuum would not thus be correct. The hypothesis that a sublimation of the carbon is produced, like that obtained by Moissan with the electric arc, could also not be sustained, for such a phenomenon would not give place to the ramifications just referred to. From his observations Signor Tolomei concludes that the destruction of the filaments is effected approximately as follows: Certain mineral bodies contained in the filament are melted by the high temperature, and in consequence of their evaporation the carbon undergoes a progressive disintegration; certain very minute particles of carbon are thrown upon the glass. When the explosions of the minute protuberances of the surface are violently produced, whole fragments are detached, and it is in the places whence these fragments are detached that most frequently the rupture of the filament finally happens. This explanation is not entirely satisfactory. Very fine filaments, richly nourished by the carburation (the carbon thus deposited containing no mineral substance), decompose and blacken the globes, as also those which have been feebly nourished. Besides, the degree of the blackening of the lamps and the durability of the filaments depend very largely upon the carburation of the latter, facts which are difficult to explain by Tolomei's theory.

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The Indian Telegraph Department.—In its annual review of the working of the Telegraph Department during the year 1894-95, the Government of India gives expression to the opinion that the working of the department is highly creditable to the Director-General and the staff of the department. The past year's report shows that the department's reputation for successful and economical working is fully maintained. During the year, 1,941 miles of line, involving 4,000 miles of wire, were added to its already enormous charge, the total being now 44,648 miles of line, requiring a length of 138,256 miles of wire, and representing a capital outlay sunk in the operations of the department of no less than 574 lakhs of rupees. The department is seemingly as successful in its financial affairs as it is in executive matters, for the revenue returns show a balance on the right side. The gross receipts amounted to 80 lakhs of rupees, against a total expenditure of 57 lakhs, leaving 23 lakhs as the net receipts. This would have been better by 4½ lakhs but for a special rebate to that amount made to the East Indian Railway for rent charges for seven years ended with 1893. The report is simply a record of continued improvement throughout. Private traffic exhibits rapid progress, an increase of 218,982 having taken place in the number of messages sent over the wires. State inland messages decreased in number, but increased in value, this being accounted for by the recent military operations in Chitral. On the whole, the net revenue receipts for the year are equivalent to a return of a little short of 4 per cent. on the capital outlay. The actual messages sent over the wires during the year were 3,200,000, or an increase of no less than 1,700,000; the increase during the last 10 years has been 111 per cent. in number and over 96 per cent. in value. The speed of transmission has also been fully maintained. Over the whole length of line and the area covered by it only a little over 2,000 interruptions had to be recorded, while the number of complaints entered is an insignificant 1,500. Readers will remember the arduous task so successfully carried out in the Srinagar-Astor connection over the inhospitable Himalayan mountain passes; and, again, the work on the Bhamo-Momein frontier, which gave India overland telegraphic communication with China. Both these works are well in the front rank of telegraphic history, and deservedly so. Very few outside the circle of those who have had the work to do, the *Indian Engineer* remarks, can ever thoroughly estimate the nature of the operations and conditions of labour, self-sacrifice, and danger which such projects involve, and their successful completion in the face of all the difficulties met proves the Indian Telegraph Department to be second to none throughout the globe.

The Comparative Efficiency of Driving Ropes and Belts.—Prof. D. S. Capper read at the last meeting of the Institution of Mechanical Engineers a paper embodying a translation of the "Report on the Lille Experiments upon the Comparative Efficiency of Ropes and Belts for the Transmission of Power," and his observations thereon. The author remarked that in almost all these experiments the chief object has been to determine the limit of load under ordinary working conditions, beyond which a belt will slip upon its pulley. The work of Morin left out of account the effect of speed of slip upon the frictional coefficient; and although Messrs. Briggs and Towne recognised its influence, they were unable to carry out experiments of a satisfactory kind at the speeds of slip due to the elasticity of belts under ordinary working conditions. Other experimenters, working at lower speeds of slip, obtained conflicting results; and it was not until 1882, when Prof. Holman experimented at varying speeds of slip with the express object of finding the cause of the discrepancies, that the coefficient was known to vary from 0·58—the value obtained by Morin and Mr. Towne—down to 0·12, when the speed of slip was sufficiently reduced. Since then Prof. Lanza has set all doubt at rest by a careful and elaborate series of tests, in which the average speed of slip under ordinary conditions has been determined, and the value of the coefficient of friction for that speed found to be 0·27, a value which Mr. Towne accepts as more accurate than that which he was forced to deduce without direct confirmation. It is therefore possible to ensure that no excessive loss shall occur from slip. But there still remain residual losses—slip due to elasticity, work in overcoming the stiffness of belts, reduction of the coefficient at high speeds by centrifugal action and by air—about which very little is definitely known. The experiments of Mr. Lewis and M. Leloutre tend to show that the total loss in well-designed belt gearing does not exceed 3 or 4 per cent. of the gross power transmitted, and M. Fauquier has investigated the losses due to stiffness, with results which require confirmation before they can be deemed conclusive, and with which the observations of Mr. Lewis directly conflict. By the Lille trials it has been shown that ropes are practically as efficient as belts, though some slight doubt has been cast upon the actual value as previously determined of the losses in belt gearing, from the fact that the variation which was found between individual observations at Lille exceeded 3 per cent. It is to be regretted, Prof. Capper added in conclusion, that it was not found possible with such a unique installation to extend the limits of the research; but it must be admitted that the difficulties were great, and the increase in the outlay would probably have been large.

The Catteri Electric Railway.—It is perhaps well that Dr. Albert Battandier thinks highly of the method of working electric railways devised by Captain Cattori, in order that the inventor may be spurred to further efforts, as the present attempt will find few other supporters. The learned doctor says that we are to owe to Italy the removal of the last obstacle in the way of the employment of electric traction on railways. In the Cattori system the current is conveyed to and from the car by the rails, the return wire for each section of the line being laid by the side of the track. The one rail is thus used as lead and the other as return. It follows that the rails must be insulated from each other, and the wheels must also be insulated from the axle. Calling the rails A and B, when a car enters the section the current goes by the rail B up to the car, from rail B through the car motor to rail A, and thence in front of the car along rail A to the return wire. The line is single, and naturally there is some complication at passing-places, but an arrangement for these has been worked out. The insulation of the wheels is effected by a hub of *lignum vitæ*, or, we are informed, "if hardened paper wheels with iron or steel tires are used, as in America," perfect insulation is obtained without further trouble. Contact brushes and wires take the current from tires to the motor. The rails are above the ground, not level with it, and continuity is secured between them by copper connections, the ends of which are driven into holes drilled into the rails, or one of the holes of the fishplate is used. There is nothing to fear from rain, we are told, since water flows off the line to the ballast, and snow can be dealt with by a sweeper car. Moreover, a heavy current and a low voltage can be used. To test the system, an experimental track about 700 yards long has been constructed with rough ballast and old railway

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sleepers. The rails were spiked down with spikes which were too long and passed through the sleepers, so that their points protruded. Dr. Battandier considers that as in spite of this the cars ran, "it must be confessed that the Cattori system triumphed over all difficulties." It would be interesting to learn what proportion of the total current supplied to the line was used in the motor when the ballast was damp, and what proportion leaked. It would, perhaps, be as well to determine the amount of the leakage before converting all our railways into Cattori lines, even though, as must be remembered, they would still remain available for steam traction, provided the wheels of the engines and rolling-stock were made non-conducting. We would suggest to the inventor of this most novel system that one advantage has escaped his notice. He should let the ground between the rails to a firm of electroplaters, who would be able to utilise the leakage currents; or, better still, by making a trench down the centre of the track he should manufacture the Hermite solution for deodorising sewage in it.

The Fetish of Public Safety.—A writer in the *Railway Times* comments, under this title, on the Portrush Electric Tramway crisis as follows. He has, of course, not seen Major Cardew's report to the Board of Trade, which we publish on another page: "If for the sake of argument it were admitted that Mr. Walne came by his death through electric shock, we are far from thinking that the circumstance would justify a prohibition of the present system of conducting electricity. Public safety has been made far too much of a fetish in this country. The Regulation of Railways Act has stifled light railway enterprise and deprived outlying agricultural districts of many lines which would have been a boon and a blessing to the struggling farmer. The perennial agitation against level crossings is only another phase of the folly which forgets that cheap and rapid transit is at least as important as immunity from accident. If Mr. Walne had been thrown on his head against a stone wall he would probably have died all the same, but the public would have learned of the sad accident with equanimity and there would have been no agitation for the removal of such dangers from the path of the unwary cyclist. If electric railways like the Giant's Causeway line were as numerous in the United Kingdom as leaves in Vallombrosa the number of fatalities due to electric shock would certainly be far smaller than the number of those due to indecision in crossing the Strand, but no one, so far as we are aware, proposes to do away with the cabs and omnibuses which render life in that thoroughfare so precarious. The Giant's Causeway Electric Railway and Tramway Company have done a very excellent work. It was the pioneer electric line, and it first demonstrated the commercial value of electricity as a motor. The railway has rendered incalculable service to the beautiful district through which it passes. Instead of the 5,000 visitors who went to the Giant's Causeway in 1882, 100,000 people visit it now, and the whole district has derived benefit from the development of the means of transit. In the very nature of the case, goods traffic is conspicuous by its absence, and, with only tourist traffic to rely upon, the company would have been unable to earn the smallest modicum of dividend had it not been possible to utilise the motive power available from the falls of the River Bush, by means of a conducting rail carried cheaply along the roadside. Any new regulation requiring the company to carry this conductor underground, or otherwise protect it, would inflict upon the undertaking fresh capital expenditure which it is ill able to afford, and we trust that the Railway Department of the Board of Trade, recognising the services which have been rendered to the community, will think twice before saddling the company with onerous conditions in the interests of 'a few local owners of cattle,' or even in those of that modern fetish, 'the safety of the public.'"

The New Alkali Process.—The new Castner-Kellner process for the manufacture of caustic alkali and bleaching powder by means of the electric decomposition of salt or alkaline salts has aroused considerable interest in electrochemical circles. Mr. Jas. Hargreaves, of Widnes, writes: The decomposition of salt by electrolysis is a subject at which I have worked more or less as a dilettante from 1875 to 1890. At the latter date the late Mr. Thomas Bird and myself went thoroughly into the matter, Mr. Bird's time and labour being exclusively employed in these researches until the date of his death at the beginning of the present year. As a preliminary we closely examined all accessible data, and all the ideas we could ourselves think of, which included pretty nearly all the ideas covered by the Castner and Kellner patents. In making this remark, I am not in any way hinting that the same ideas did not originate with these gentlemen, or that they have not the most perfect right to secure them by patent. The use of mercury seemed very tempting at first, but we found that it presented difficulties of its own in working. But apart from, and beyond, the question of manufacturing, the physical properties of mercury were carefully considered, in which the researches of Regnault and Merget were of great assistance. At 10deg. C. = 50deg. F., its vapour tension is 0·0268mm.; at 20deg. C. = 68deg. F., 0·0372mm.; at 30deg. C. = 86deg. F., 0·0530mm. Mr. Castner's assertion, that "as the reaction takes place under water there is no escape of mercury," is an error. I should have thought that Prof. Sir Henry Roscoe being on the board of directors, it would not have been necessary to have these facts pointed out. The sodium amalgam is decomposed by contact with water, the oxygen of which is absorbed by the sodium. The hydrogen of the water is strongly occluded by the mercury forming practically an amalgam of hydrogen and mercury, the decomposition of which is due to the very high vapour tension of the hydrogen. This forms one of the difficulties of separating the very small proportion of sodium present in the amalgam after it leaves the anode cell, and ensures that the hydrogen shall be fully saturated with mercury of the tension due to the temperature at which it escapes from the surface of the metal. The question to decide is whether the statements of Mr. Castner, or those of Regnault and Merget, are to be accepted. Anyhow, those who have the facilities may try the experiment for themselves. Into a bottle with water on the bottom, drop from time to time small pieces of mercury amalgam, suspend a strip of gold-leaf in the bottle, and expose it to the hydrogen which escapes from the water. After a time the gold-leaf will be tarnished by the mercury which it extracts from the hydrogen. It must further be borne in mind that the mercury thus deposited is only a very small proportion of the total mercury carried off by the hydrogen. Those who interest themselves in the question will find the researches of Regnault and Merget discussed in *Comptes Rendus*. I do not quite remember the years, but a search through 1870, 1871, and 1872 will find them. After considering the facts, my colleague, without waiting for my opinion, emphatically declined to have anything to do with a business so likely to injure his fellowmen, no matter what profit it might bring. My own feeling was precisely the same, but I have a distinct remembrance of feeling hurt by his emphatic manner, because it seemed to hint that I should have been content to make a profit by such a means. From this Mr. Castner will learn why his patents were not anticipated.

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THE ELECTRICAL PLANT AT THE WATERLOO AND CITY RAILWAY.

BY R. W. WEEKES, WHIT.SCH., A.M.I.C.E.

This railway, which is to provide the much-needed communication between the Mansion House-circus and Waterloo, is being rapidly constructed by Messrs. J. Mowlem and Co. As described in our issue of March 1, 1895, the line is being excavated on the Greathead shield system, and will eventually be worked electrically. It is seldom, however, that electricity has been so extensively used as an aid to the contractor in executing railway work. Messrs. J. Mowlem and Co. obtained the contract for carrying out the work for the Waterloo and City Railway Company. Having seen from previous experience the possibilities of electric traction, they decided to adopt it to assist in the excavating process, and retained Messrs. Bramwell and Harris to draw up a scheme for their electric lighting and traction work. The general arrangements of the works are worthy of more than the passing notice I am able to give them.

A site in the river by the Surrey shore was chosen, and a stage constructed by piling the river bed. There two circular caissons were sunk down into the clay till the level of the line, some 70ft. down, was nearly reached. The lower end of these iron tubes are supported on brick arches, which form entrances to the tunnels. The excavation of the tunnels could then be commenced with the Greathead shields. The shields used are similar to those which were employed on the City and South London Railway. They are pushed forward by eight hydraulic jacks, pressing against packings which bear on the finished part of the iron tube, and spaced at equal distances round its circumference. By working some of the hydraulic jacks and stopping the others the direction of the shield can be varied as may be desired. An advance heading, strongly timbered, is kept a few feet in front of the shield; and the excavation is done entirely by means of pick and shovel. The soil dug out is loaded at once into skips, which stand on low platform trucks running on rails of 18in. gauge. These skips are coupled together, and the loaded train is hauled to the shaft by electric locomotives. Steam cranes on the staging raise the skips to the surface and empty the soil into barges alongside. It is in this that the position of works are so advantageous. The whole of the transport, both of the excavated material and iron lining, etc., for the tunnel can be effected by water. This greatly facilitates and cheapens operations. The whole of the boilers and machinery for compressing air and for generating electricity are placed on the staging. The consulting engineers, Messrs. Bramwell and Harris, fixed the voltage for lighting purposes at 100 volts, and adopted 200 volts as the pressure for traction purposes. Hence, they arranged that at first two shunt-wound dynamos, each giving 112 amperes at 100 volts, should be used, and should be run in series for driving the locomotives.

The contract for the generators was given to Messrs. Paterson and Cooper. The first machines were each coupled to a 7½ × 7 Robey engine, running at 300 revolutions per minute. A third similar set was added, and then a larger coupled plant was ordered for traction purposes only; this steam generator is capable of giving 145 amperes at 200 volts when running at a speed of 250 revolutions. The engine of this set was made by Messrs. Browett, Lindley, and Co., and the dynamo was also supplied by Messrs. Paterson and Cooper, who have kindly given me the following details of it: The armature is 16½in. diameter and 24in. long, and is Gramme wound. It is a shunt machine, the resistance of the shunt coils being

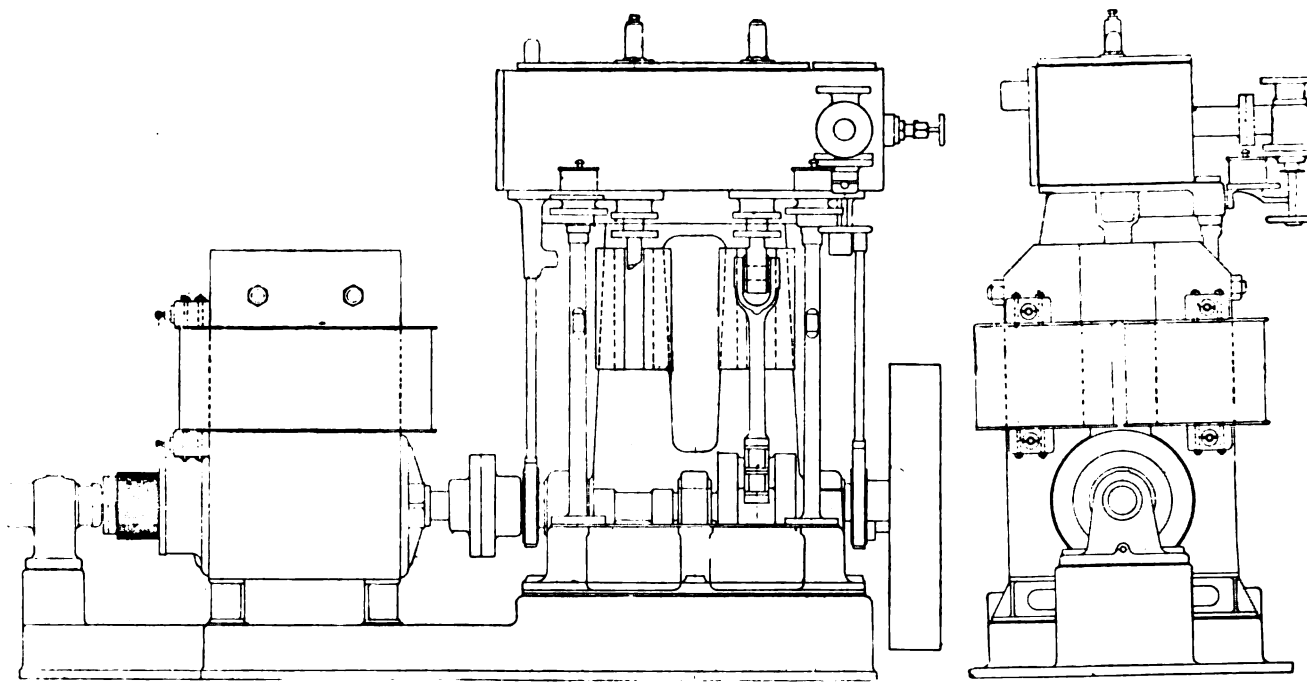

FIG. 1.—The 29 K.W. Paterson and Cooper Dynamo Coupled to Browett-Lindley Engine.

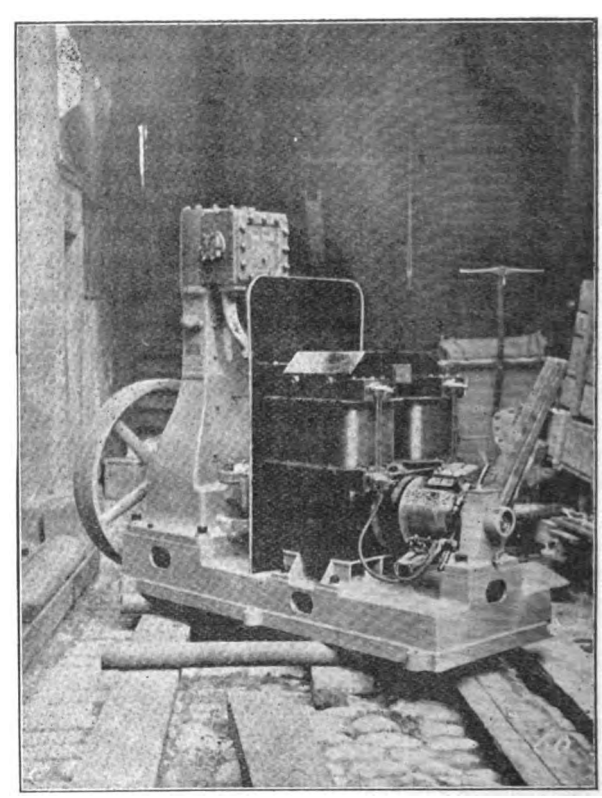

FIG. 1A.—The 11 K.W. Steam Dynamo.

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41 ohms, and that of the armature ·066 ohm. Fig. 1 shows the construction of this set.

The three smaller machines have each an armature of 12½in. diameter by 14¾in. long, the armature resistance being ·065 ohm. Fig. 1A shows one of these smaller sets before being fixed in position. The crowded state of the engine-room does not permit of a photograph of the steam dynamos in position being taken. Thus on the one end of the stage there are five locomotive boilers—three of which are of 100 h.p. and two of 120 h.p., in a small boiler-shed—two large air-compressors, by Messrs. Markham and Co., and the electric plant above mentioned. It speaks well for the care of Messrs. Mowlem and Co.'s engineer that all this machinery should be working satisfactorily on such a foundation.

The Locomotives.—The design of these has varied considerably, as improvements have been suggested from experience gained in work. The consulting engineers specified that the locomotive should be capable of drawing some five tons on the level at a speed of from six to seven miles per hour, or up a grade of 1 in 60 at a speed of three miles per hour. These requirements have been most amply met by Messrs. Siemens Bros., as on my visit I took the speed of a trip when the load was eight tons, and it averaged 9¼ miles per hour with a grade of 1 in 800. When running light over the same portion of the road, a speed of 12·6 miles per hour was easily obtained. Three locomotives have been supplied by Messrs. Siemens Bros. and Co. up to the present. The first one was started on February 25, and has since run for some 200 days of 24 hours without repair and with only one set of brushes. For 18 hours a day the locomotives work at full pressure. The second locomotive was started on May 4, and has been at work ever since. The third was started on October 1, 1895.

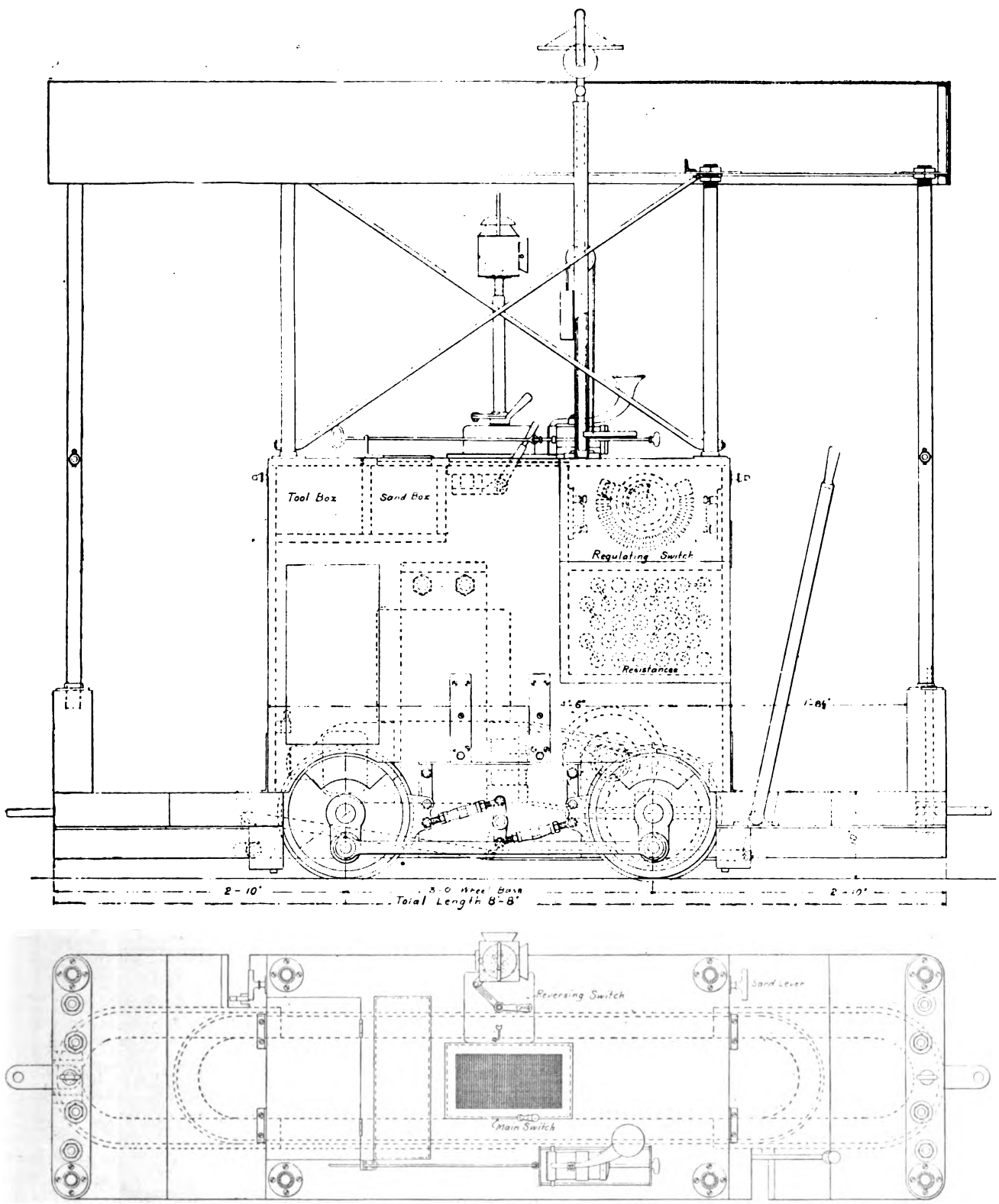

FIG. 2.—The No. 2 Siemens Locomotive.

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The narrow gauge of the line and the necessity of having one siding at the working face and two under the shaft seriously cramped the design. The actual width available, owing to the circular form of the tunnel, is a little over 10ft., and the width of the locomotive had to be considerably under one-third of this to enable it to safely pass places where skips are standing on the sidings at either side of the centre line of rails. The illustrations (Figs. 2 and 3) show the second of these locomotives, in which the frame was lengthened to give standing room at each end. The motor, which is of the Siemens H.B. 8.10 type, has been most carefully protected against damp. The series coils are surrounded by metal cases, which are hermetically sealed. These can be seen in Fig. 4. The armature is also surrounded by gunmetal castings, handholes covered by slides being provided for the inspection and adjustment of the brushes. The brushes are made of copper gauze, and are placed end on to the commutator. They slide in rectangular guides, and are held against the commutator by springs. The clearance between the brush holder guide and the commutator is barely $\frac{1}{16}$in., so that the brush does not burr over. This construction has worked most satisfactorily, and enables the motor to run in either direction. There is no provision made for varying the lead with the direction of rotation, the brushes being fixed on the centre line. The gearing connecting the motor to the axles is a double-reduction. A bevel pinion of phosphor bronze is keyed on to the armature shaft outside the end bearing, and gears into a bevel wheel of cast iron. A steel pinion on the same shaft as this bevel wheel drives the cast-iron spur wheel on the axle (Fig. 2).

As can be seen from the illustration, the whole of the gear is encased. The spur gearing and bevel gearing run in oil, and when examined after four months' work

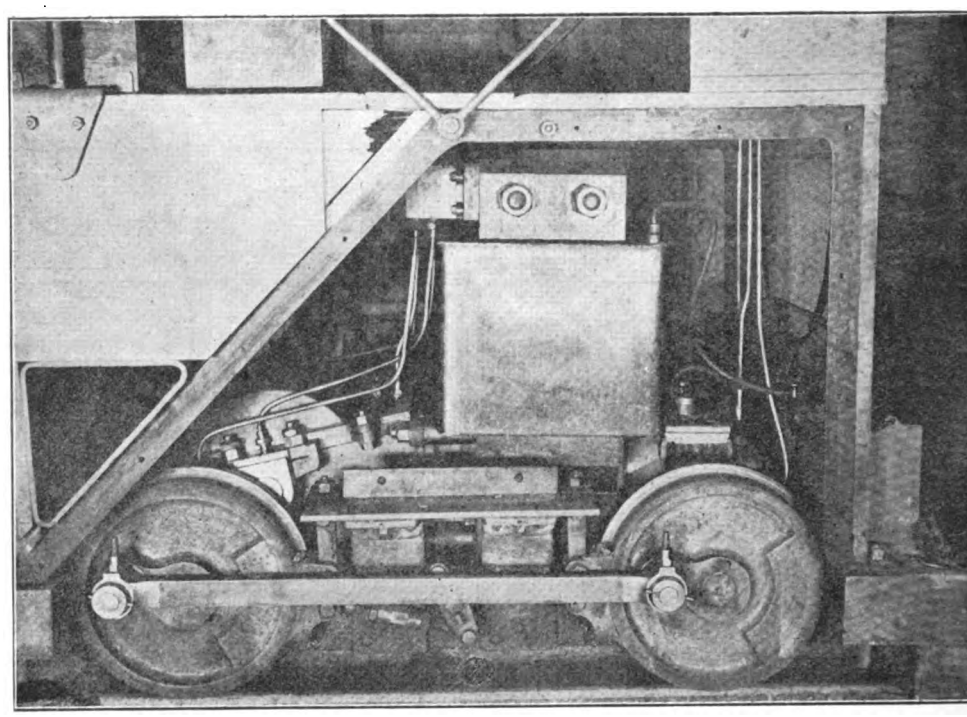

FIG. 4.—View of Locomotive with Cover Removed to show Driving Gear.

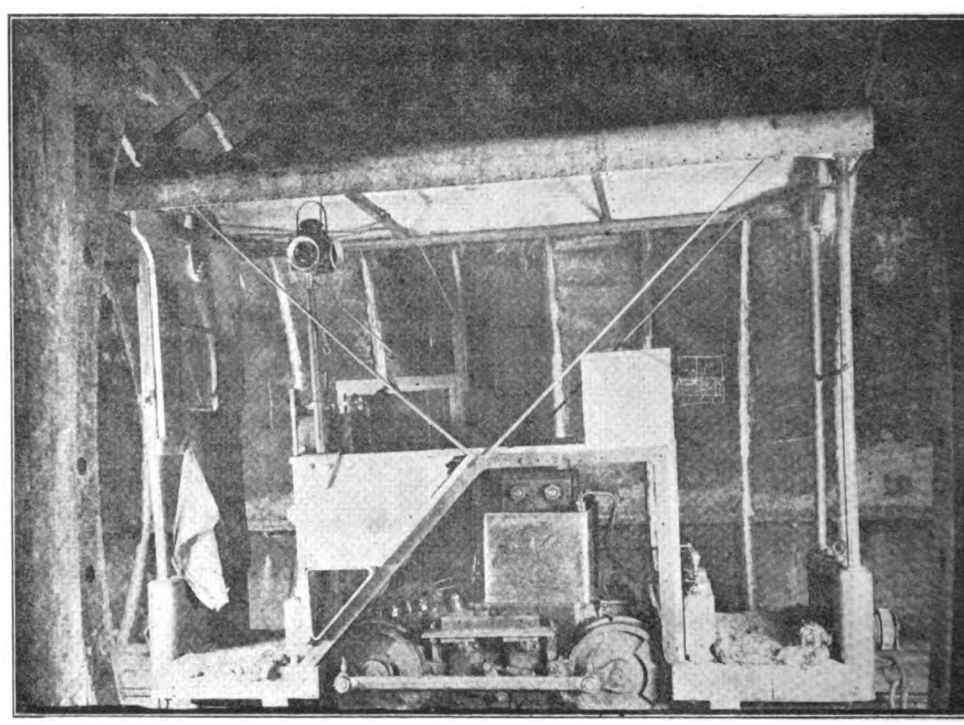

FIG. 5.—Side View of No. 2 Locomotive.

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were found to be in perfect order, the surfaces of the teeth being polished and glazed. The wheels of the locomotives are coupled by connecting-rods. In the first design the starting and regulating switches were connected to the brake levers, so that the locomotive could be driven from either end. The forward motion of the brake lever first took the brake off, and then switched the current on. This method has, however, been abandoned, and the brake lever has been replaced in the last locomotive by screw gear, which is more satisfactory. The reversing switch is geared

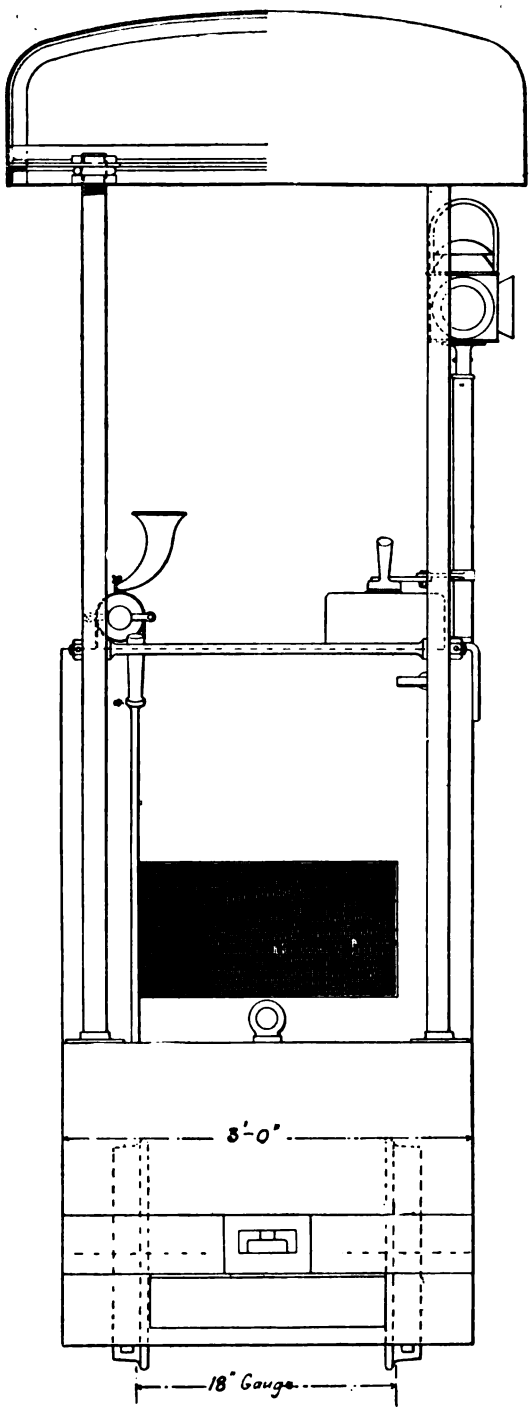

FIG. 3.—End View of Locomotive.

to the red lamp on the locomotive, so that it always turns the light to face in the direction in which the train is moving. The locomotive is strongly built on a wrought-iron frame, and covered in with wooden sides, which can be readily removed for inspection or cleaning. The whole of the canopy and switch gear can be readily removed. The connections from it to the motor are made by means of four plugs and flexible leads, seen in Fig. 4. The regulation of the motor is wholly carried out by means of resistances inserted in the main circuit, the number of series-turns on the field magnet remaining constant. Fig. 6 is another view of the second locomotive, and Fig. 7 shows the alterations effected in the third locomotive, and which have given great satisfaction. The starting switch on this locomotive is placed in full view, and has a glass front. The weight of the locomotive complete is about three tons.

Collecting Gear and Line.—From February to June a two-wire overhead system was used, with a trolley slipper running above the wires. This was on account of the difficulty which it was anticipated would be experienced in reversing the locomotive with the ordinary under-running trolley construction, in consequence of the limited head-room in the tunnel. It was thus decided to use an over-running trolley carriage, hauled by means of a twin flexible cable. This arrangement also permitted of the use of the main line trolley wire at sidings, the "angle of pull" of the cable on the trolley carriage not being sufficient to cause any trouble in this respect. The construction, however, gave trouble when the two wires were not strained equally. Also, as the line required frequent lengthening, the extension caused some difficulty with the two wires, so that finally

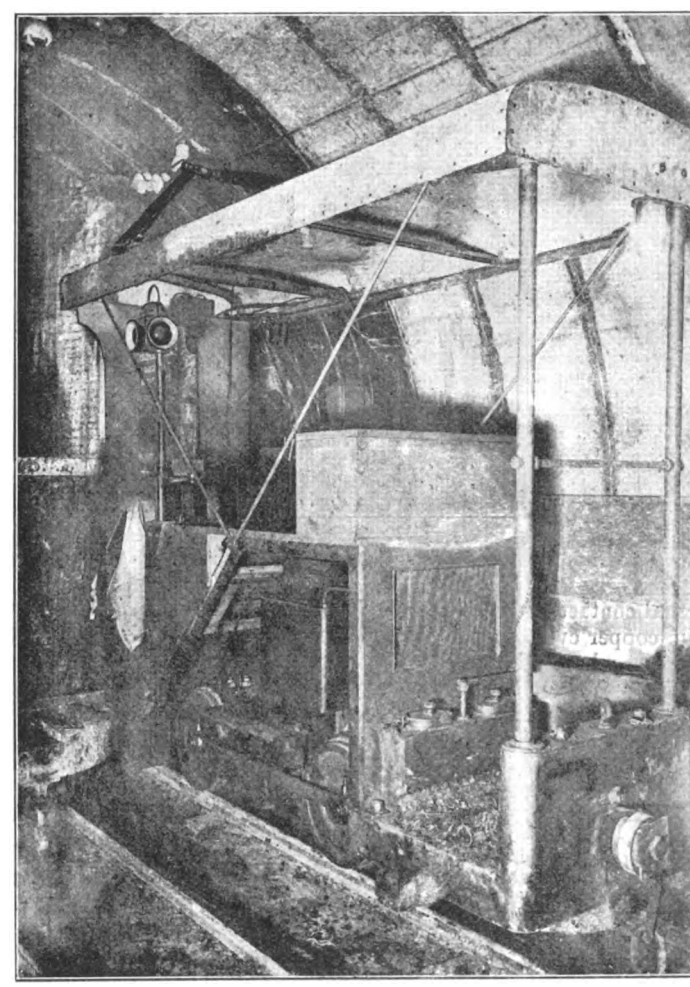

FIG. 6.—End View No. 2 Locomotive

it was decided to abandon the return circuit and to work with an earth return and a single conductor only. When crossing the shaft also trouble was found with the two-wire system, as the conductors do not cross the space. Hence the flexible leads had to be disconnected from the locomotive each time, and those on the other side connected again, before the locomotive could proceed.

With the single-wire system, owing to the limited height available and the dip necessary when going on to the side roads, and also to the fact that time could not be allowed to reverse the lead of collection when reversing direction, there was some difficulty in designing a suitable collector. Another special condition which added to the difficulty was having to cross under the shaft where it was impossible to carry the trolley wire. Mr. H. Allen, the electrical engineer in charge of the work for Messrs. Mowlem and Co., has designed two forms of collectors to comply with these conditions. The first is the telescopic pattern shown diagrammatically on the car in Fig. 2 and in detail in Fig. 8. The vertical pressure of the collector against the wire is maintained by the action

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of weights, whilst indiarubber springs allow the collector to take a certain amount of lead in whichever way the locomotive is running. The other collector is always inclined at an angle to the wire, but when the locomotive is moving in one direction the angle is against the motion. In this collector, again, the pressure is maintained by weights. The current. The whole of the line material has been also supplied by Messrs. Siemens Bros. and Co.

At present the two tunnels extend about a quarter of a mile in either direction from the shaft. One locomotive is always at use in each tunnel, working somewhat as follows: It draws a batch of empty skips up to the City end of the

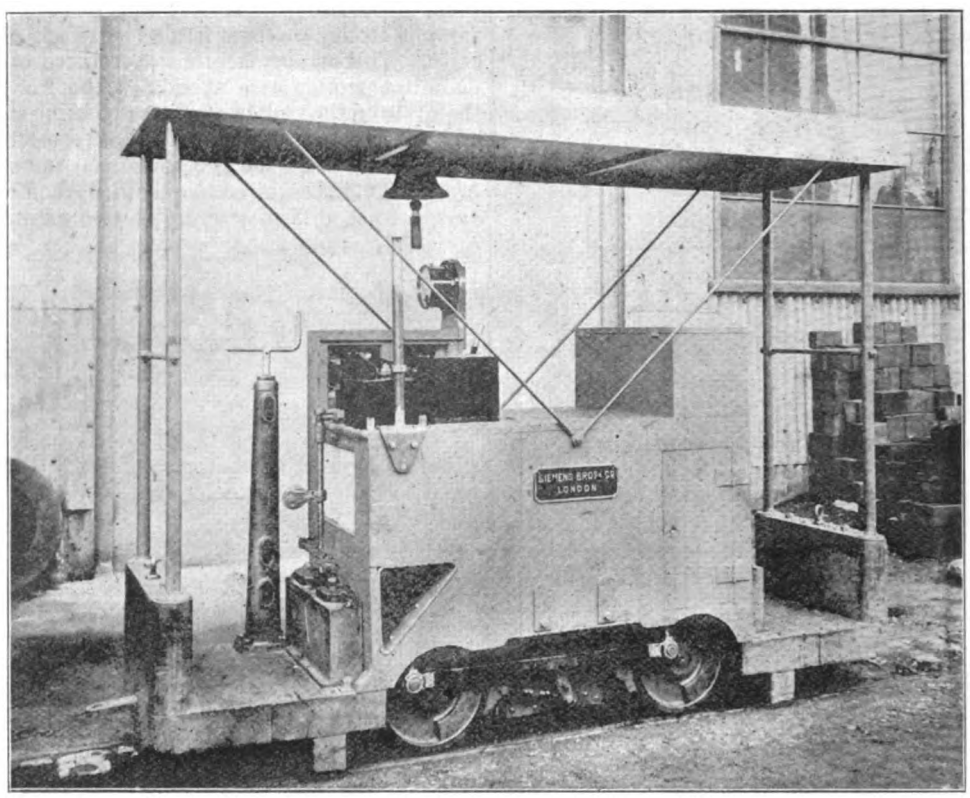

FIG. 7.—View of No. 3 Locomotive.

actual contact with the wire is effected in both cases by a 2in. copper cylinder some 13in. long, which allows ample margin when taking the points. The trolley wire is of 0·25in. diameter hard-drawn copper, held in "ears," which grip it by means of two set screws in such a way as to leave a clear section of wire (Fig. 9). About 1½ miles of this is tunnel and shunts them into one siding there. It then pulls a train of about eight loaded skips to the shaft, and takes another set of empties up to the Waterloo end of the same tunnel. An idea of the frequency of the journeys can be obtained from the load curve taken from the generator on the 28th ult. (Fig. 10). At the Waterloo end of

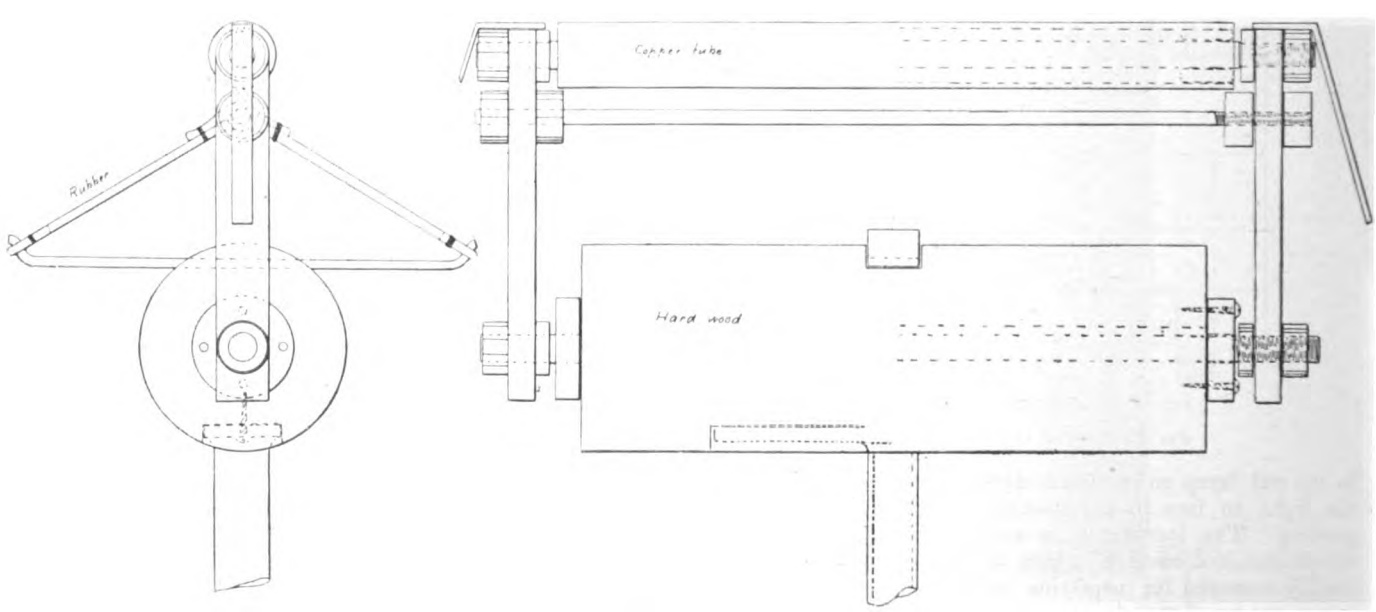

FIG. 8.—Details of Vertical Collecting Gear.

now fixed in the two tunnels. The method of insulating the wire and of attaching it to the iron segments of the tunnel is easily understood from the illustration. The return circuit is made through the rails, which weigh 56lb. to the yard. The rails have no special bonding arrangements, but are connected at intervals to the iron lining of the tunnel, which forms a most efficient return path for the the tunnel gravel has been found, which necessitates the use of compressed air to keep the water out of the workings. Hence air-locks have been inserted, and a pressure of about 32lb. absolute is maintained beyond them. The locomotive works up to the air-lock, but on the pressure side the skips are pushed by hand.

At both the compressed-air faces the Greathead shield

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is moved forwards by electric motors driving three-throw pumps by means of worm-gearing, which gives a pressure up to 1,700lb. per square inch. These pumps (Figs. 11 and 12) are placed on rails and fastened by a wire rope to the "shield," so that they advance with it. The motors are made by Paterson and Cooper, and are of their $9\frac{1}{2} \times 4\frac{1}{2}$

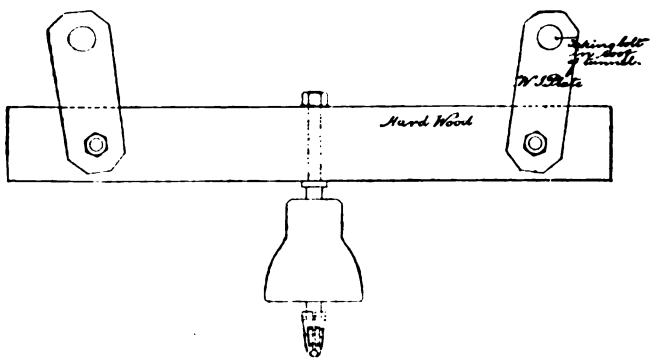

FIG. 9.—Detail of Line Support.

size, series wound, taking 35 amperes at 200 volts when running at 1,400 revolutions. The pumps are by Gwynne and Co., and are of the three-throw type, with rams $1\frac{1}{2}$in. diameter and 3in. stroke.

The lighting of the tunnel is carried out by incandescent lamps connected to bare wires supported on insulators, and these extend up to the face, where additional lights are required. The wires for lighting and power purposes are carried through the brickwork of the air-lock in iron tubes fitted in with an insulating compound. The four faces, the engine-room, and the offices are connected by telephone to a small exchange at the bottom of the shafts. The telephones use the same earth circuit as the locomotives—viz.,

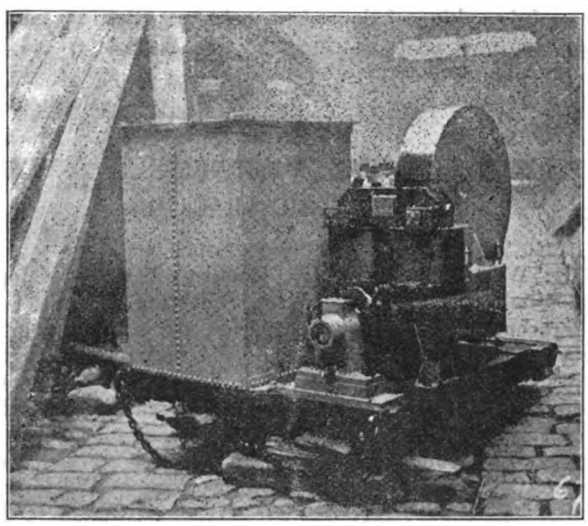

FIG. 11.—View of Electric Pump.

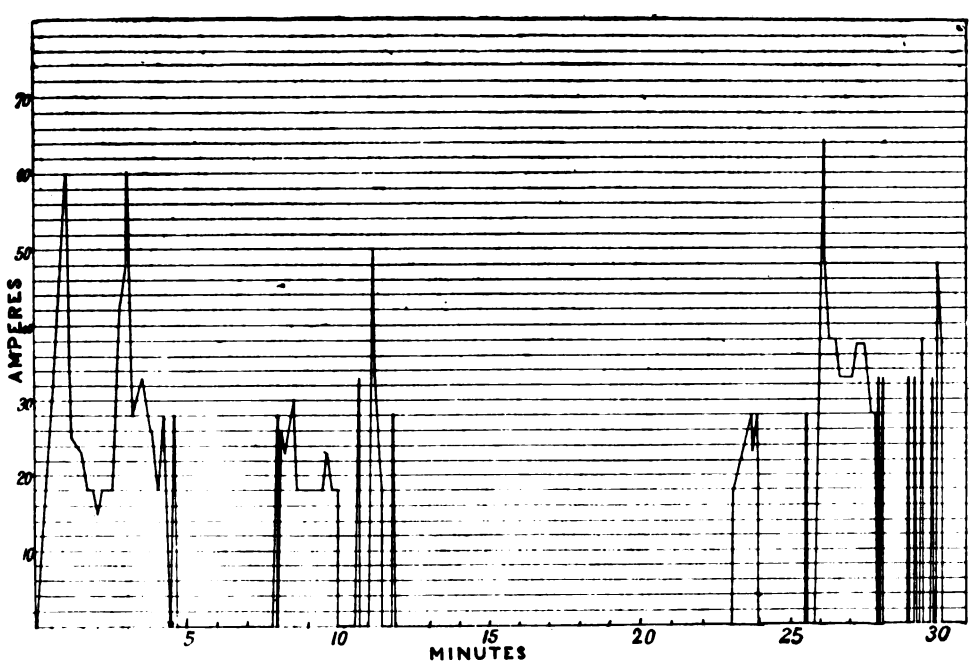

FIG. 10.—Load Curve Taken October 29, 1895.

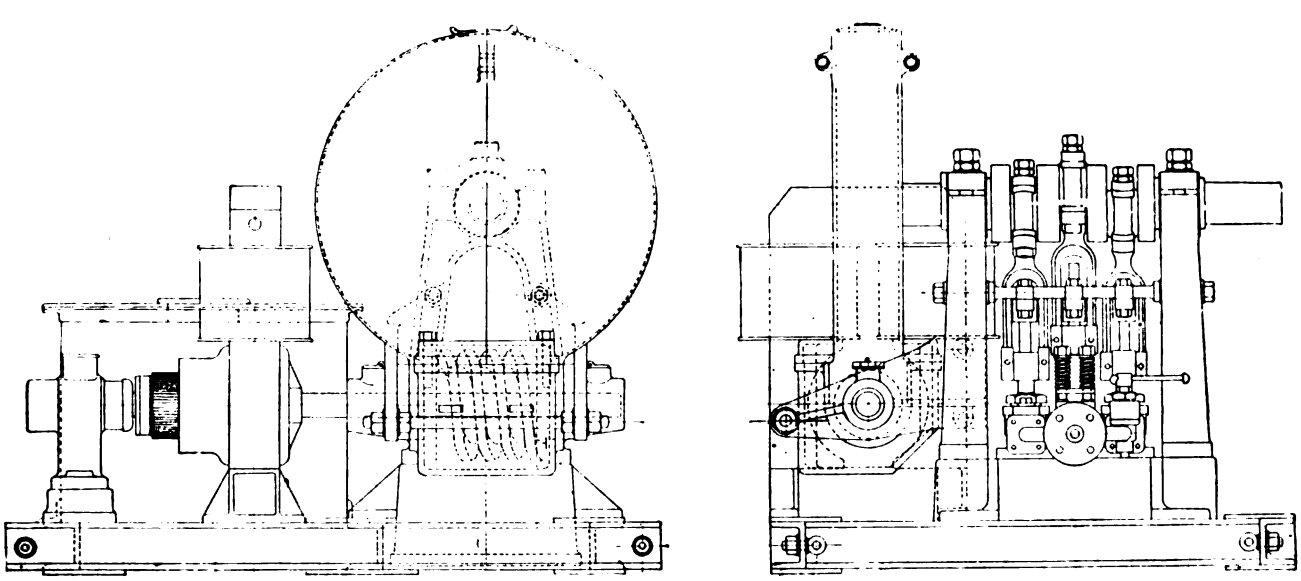

FIG. 12.—Details of Electric Three-Throw Pump.

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the iron tube—and not the slightest disturbance is noticed rom this method of working.

Messrs. Mowlem and Co. are to be congratulated on the successful working of their electrical plant, and great credit is due to their electrical engineer, Mr. Allen, for keeping the traction plant in good order.

THE WESTINGHOUSE UNDERGROUND SYSTEM FOR ELECTRIC TRACTION.

The Westinghouse Electric Company having developed the Wheless contact system of collecting current from underground conductors in America, are now placing the same on the English market. We understand that a contract for the equipment of a line on this system is likely to be signed at an early date; but in the meanwhile a most interesting working model of a car and track is on view at the company's offices in Victoria-street, Westminster. The system has been in working in Washington for about 18 months, and has given satisfaction. The Westinghouse Company have also equipped the railway

In this new system the ordinary electric car such as is used in either of the other systems is employed. This car carries a small battery, the poles of which are attached to collecting bars placed under the car, which make contact with small iron discs, which project from the roadway. These bars are approximately the length of the car, so that as long as the car covers a set of points they are connected to the battery above referred to. Two of these discs, or points, as they are called, form the terminals of the wires of a small electromagnetic switch, placed in a box buried at the side of the roadway in the case of a single-track and between the tracks in a double-track line system. When the current from the small battery carried by the car passes through one of these switches its armature is attracted, and the current from the main is then switched on to the third contact point, forming part of the group of three in the roadway (Fig. 2). This third contact point is rubbed by a corresponding bar carried by the car, which thereupon becoming charged from the main conveys current to connections from the motor on the car in the usual manner. It will thus be seen that this third point is only connected with the main as long as the current is flowing through the other two contact points from the battery carried by the car, so that when the car has passed over them the

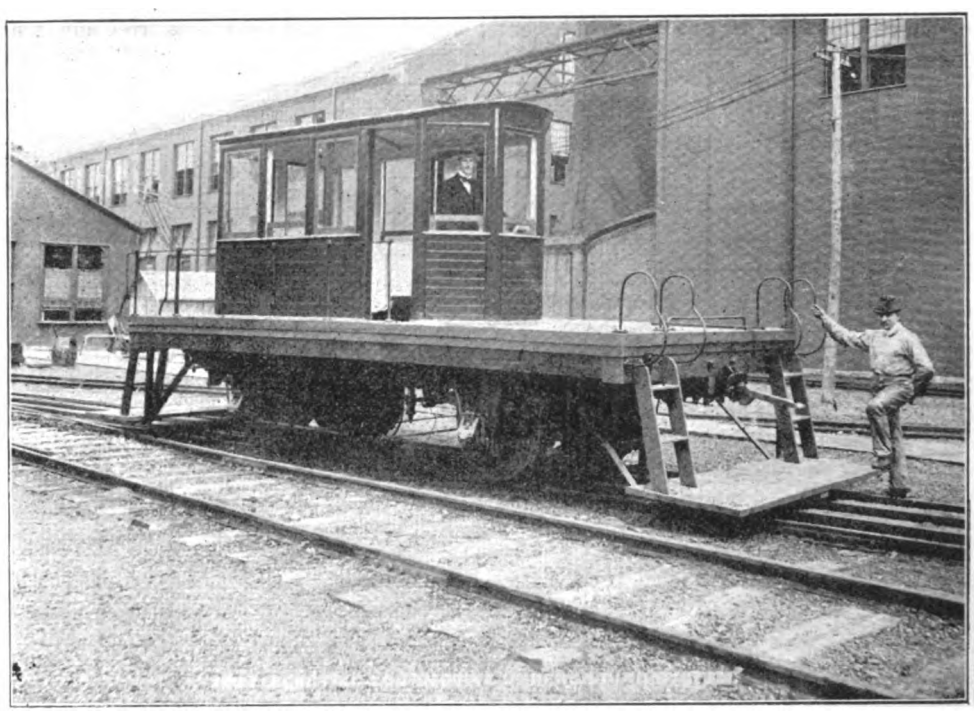

FIG. 1.—Electric Locomotive on Wheless System

sidings, etc., in their large works in America on this design. The locomotive used for this heavy shunting work is shown in Fig. 1, and is capable of dealing with trains weighing 240 tons.

Hitherto the only methods of electric traction actually used on tramways or railways have been the trolley system, the conduit system, and the third-rail system. All these have their disadvantages, and considerable objection has been raised to each of them by the public. The chief objection to the trolley system has been the unsightliness of the overhead wires; and slotted conduits, while avoiding this defect, raise many engineering difficulties in order to ensure good insulation and uninterrupted working in bad weather. Above all, they are costly. The third live-rail system, although much cheaper, cannot be entertained for street work in towns. With it, again, insulation troubles are often incurred. This new system exploited by the Westinghouse Company is a development of many attempts made by Lineff, Gordon, and others to perfect a third-rail system, in which only those portions of the rail under the car are connected to the source of supply. The rail in the road in this case is replaced by contact points only projecting a slight amount above the surface of the road.

current ceases in the electromagnetic switch and leaves the three contact points "dead," so that traffic can pass over them without the possibility of a shock to either passengers or horses. In other words, the entire system is insulated from the supply mains, except at those points which are covered by the car. The groups of points above mentioned project only ¼in. above the level of the road. Each point is about 4in. in diameter, and is made of iron, presenting a convex face to the traffic, the edge being level with the road and the centre about half an inch above. These pieces of iron are corrugated, so that there is no chance of horses slipping on them. They are placed somewhat closer together than the total length of the car, in order that the bars carried by the car make a contact with one set before they leave the previous set, and thus a continuous supply of current is obtained. The number of points in a group may be reduced to two by using the rails as a return, which in no sense lessens the safety of the system.

The construction of the electromagnetic switch is novel, and will be fully illustrated and described in our next issue.

The contact bars on the car are made of flat iron, and extend nearly the full length of the car. In order that they may keep contact in going round curves, they are

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made in three parts, hinged together, and at the front and rear of the car guiding wheels are placed, which run lightly in the ground rails, and keeps the ends of the contact bar always over the centre of the track. This can be seen from Fig. 3, which shows the model car on the track laid down at the offices of the Westinghouse Company. The system, as arranged with three contact points (Fig. 2), is provided with an insulated return wire, but as the automatic switch is single-pole the left-hand point of the two points used for switching purposes is permanently connected to this return. The switch only connects the single point in advance of these two to the leads, and disconnects it again after the car has passed. It follows that, in order to render the return points harmless, the whole return system must be earthed, otherwise the potential of this point may be at times dangerously high. When this is done, the advantage gained over one having a return through the track to a bare return buried between the rails is not so great as at first sight appears. When the rails are used as return, the number of points of collection at each switchbox are reduced to two.

This system is well adapted for use on railways where the length of trains enables very much fewer contact points being used, and the much larger surface offered for contact makes it much easier to carry a far larger current than has been hitherto done; and the safety in only having the contacts exposed at the time that the train is on them will be a great advantage in tunnels or cuttings where workmen are likely to fall against or touch any exposed point.

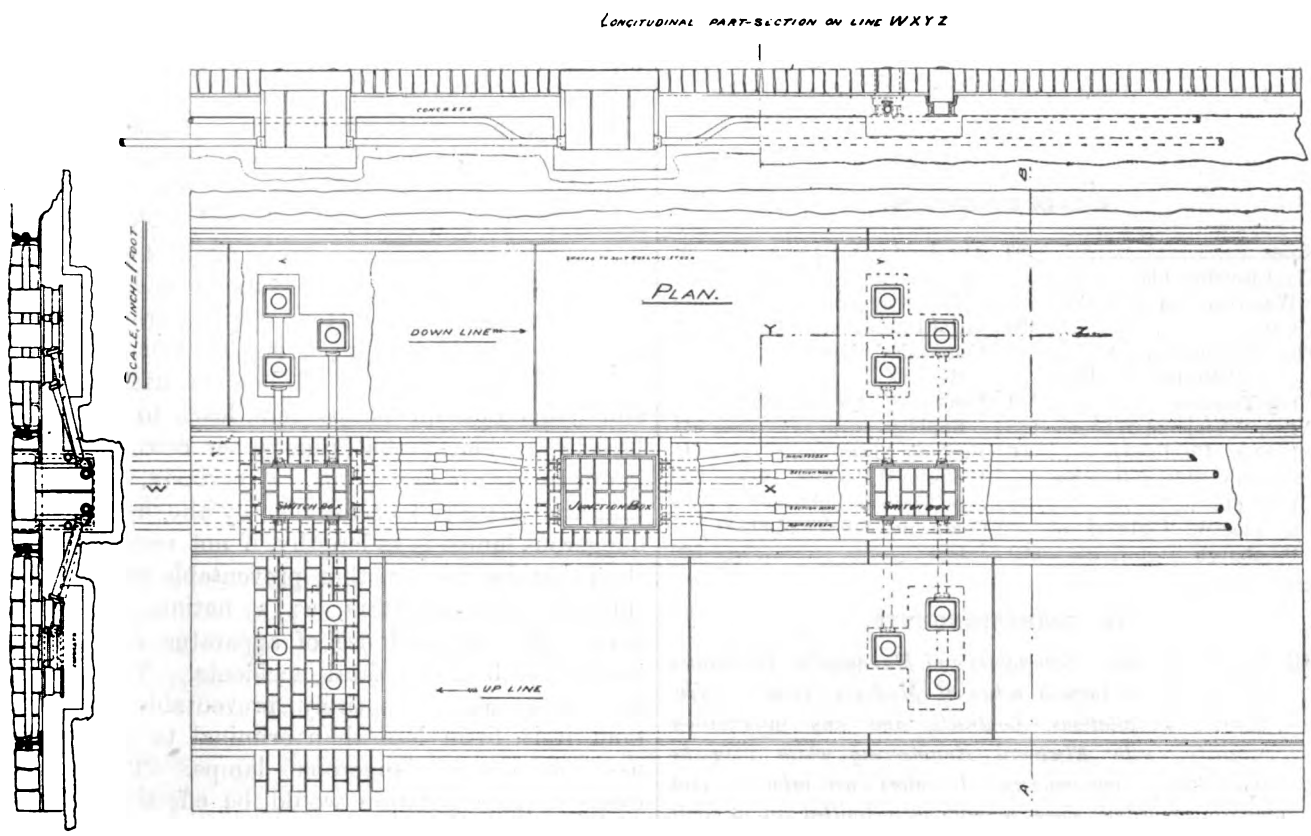

FIG. 2.—Details of Track, with Return Contact.

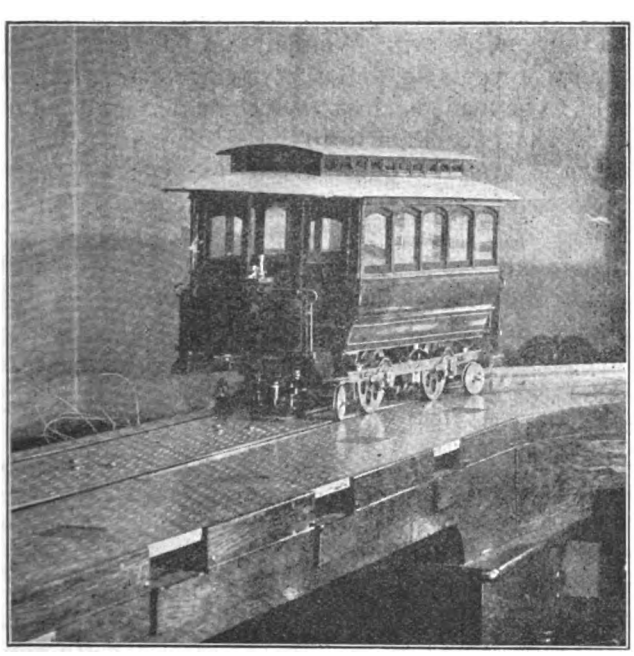

FIG. 3.—View of Model Car.

We are informed that in Washington no difficulty due to snow and ice has been found in keeping the cars running in winter. A regular traffic is stated to keep the track in running order, and the collectors and contact points do not show signs of wear after some 2,000 miles run. The cost of laying down the metallic return, all cables, feeders, switches, and the double track, was about £7,000 per mile of street equipped. In this case the return was through the tracks, but an uninsulated return was laid between the two tracks and bonded to the rails at regular intervals.

WHAT, WHEN, AND WHERE.

Physical Society.

November 8.—1. "The Field of any Cylindrical or Plane Circuit," by W. H. Everett.
2. "The Latent Heat of Volatilisation of Benzene," by Mr. Griffiths and Miss Marshall.
3. "The Comparison of Latent Heats of Volatilisation," by Prof. Ramsay and Miss Marshall.

Institution of Junior Engineers.

November 1, 8 p.m.—At the Westminster Palace Hotel. Presidential address by Archibald Denny, M.I.N.A.

Society of Engineers.

November 4.—At the Royal United Service Institution, Whitehall. Ordinary meeting. "The Effect of Strain on Railway Axles and the Minimum Flexion Resistance Point in Axles," by T. Andrews, F.R.S.

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OIL—GAS—ELECTRICITY.

There is no feeling of gratification in calling attention to the dangers of gas. These dangers are well known and recognised, but here, as in all cases, familiarity seems to breed excessive carelessness. It is easy to cry out for legislation in this and other matters, and if we suggest legislation in certain directions we shall undoubtedly be reminded of our many remarks against precipitate legislative action. However, the text of our sermon to-day is not legislation in or against the interests of gas, or even of electricity. It is in quite another direction. The gas explosion just out of the Strand, which resulted in many injured and one death, ought not to be so appalling as the continuous fatal accidents arising from the use of oil. Here again, perhaps, a too general view will lead to wrong conclusions. It is not altogether the use of oil, but the use of fragile and dangerous oil lamps that leads to accidents. Everybody knows that ninety per cent. of the oil lamps in use are dangerous. Everybody, too, knows that the death-roll occasioned by the use of these dangerous lamps is as lengthy, if not more lengthy, than that due to any other preventable cause. We, hrough our legislators, as a nation, knowingly permit the sale and use of apparatus which must inevitably lead to fatal accidents. These accidents are almost entirely preventable, and we hold it is little less than criminal to permit the use of these dangerous lamps. This is a case where legislation would be effective. There is no use in arguing that men can buy safety lamps if they choose; nine-tenths of the purchasers neither know what constitutes a safety lamp nor the properties of dangerous oil. We are not saying it because fuss ought not to be made, but there is more fuss made over one accident from electricity than over a hundred from oil. The latter seems to be expected as a necessary evil, the former is recognised as a preventable evil. We maintain both are almost entirely preventable, and that stringent restrictions ought to be made against the production and sale of lamps that are known to be dangerous. These questions are not questions of money; they are questions of murder. This is where the curse of modern civilisation sits heavy. Parliament, too eager to buy votes, votes, votes, panders to a lot of sentimental humbug out of the mouths of fools and fanatics, and year after year permits the manufacture and sale of these dangerous articles without let or hindrance. We certainly have an interest in bringing this matter forward, hence must expect what we say to be taken *cum grano salis*. The facts, however, are indisputable. From our point of view we think—we are almost tempted to say we know—that the generation and distribution of electricity for lighting purposes is safer than that of any other illuminant. There is no difficulty in going so far as to say that in the house the use of electricity can be made absolutely safe. There is a danger up to a certain point to careless workmen in the generation and distribution, but there ought to be no danger to the house or the householder. Electrical engineers know this, but they are not half energetic enough to insist upon it; and some of them, the black sheep

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of the profession, are too eager to get work at any price. The tendency of this policy leads to the wilful neglect of known precautions against danger. Far too lenient a view is usually taken of bad workmanship, and we think this arises from the fact that in the generality of instances bad workmanship does not mean life or death, though it may mean more work in the shape of renewals and repairs. Bad oil lamps, bad workmanship conducing to gas leakage, to unsafe electric wires, are a far more serious matter, and never ought to be treated leniently. So far as the first of these is concerned, we contend that all oil lamps, except safety lamps, should be prohibited by law. As regards the bad workmanship, we can do little more than to constantly point out its dangers, and trust that in future the fire insurance inspectors will penalise such contractors by refusing to pass their work.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XV.—SIMPLE PRINCIPLES AND USE OF ELECTRIC MEASURING INSTRUMENTS — AMPEREMETERS, VOLTMETERS, DELICATE MIRROR GALVANOMETERS, RESISTANCE COILS.

(Specially Contributed)

Purposes of Measuring Instruments.—We have seen that in electrical work there are three fundamental quantities to be measured:

1. Pressure, which is measured in units called volts.
2. Current „ „ „ „ „ „ amperes.
3. Resistance „ „ „ „ „ „ ohms.

It will do no harm to refer once more to terms that are constantly met with in all text-books, and which are often slightly misunderstood. What I have just called pressure is often called electromotive force, or difference of potential. Now, we may take it as axiomatic that any source of electricity, such as a combination of copper, zinc, and sulphuric acid, is capable of exerting one, and only one, electric pressure. This total pressure is the E.M.F. of the source. Frequently, nay, almost always in practice, we have to deal not with the total pressure, but with a part of the total pressure, that pressure, in fact, that is exerted between two points in the circuit under consideration. Call these two points A and B. The pressure at A is something less than the total pressure, and the pressure at B is still smaller. If we say the pressure at A = x and that at B = y, then the acting pressure between A and B is the difference between x and y, or $x - y$. If, for example, the voltage at A is 20, and at B it is 10, then the acting pressure, or the difference of potential, or the P.D., is $20 - 10 = 10$. Once more, then, E.M.F. is the *total* or the maximum pressure, while the P.D., or acting pressure, is the pressure acting between two given points in the circuit. P.D. and E.M.F. are equivalent only when the former refers to the total, while it is usually less than the latter. However, a little care will always show what a speaker or writer means. If he is referring to the E.M.F. of a dynamo it is frequently to the P.D., or acting pressure between the terminals, and not to the total E.M.F. generated by the machine. A certain part of the total pressure generated, whether by a dynamo or battery, is used up in overcoming the internal resistances, and thus only a portion is available for useful external work. It is very much the same in a steam-engine. A part of the steam pressure upon the piston is used in overcoming the frictional resistances of the engine itself, and this part cannot be made available for other useful work.

There is always a difference of pressure between two points if, when those points are put into conducting contact, electricity tends to pass from one point to the other.

The method by which we measure the pressure excited is much the same as the everyday methods used in other cases. There is no difference in the principles employed. Thus, suppose we require to know the largest load a horse can move under given conditions, let us see how we may get to know this. If you harness the horse to a light cart, you will probably find the horse can trot away with the cart with considerable ease and at a good pace. Put a few bars of lead in the cart, and the horse experiences more difficulty in pulling it along. Continue to put more and more lead into the cart; you come to a point where the horse can just move the load, and if a little more lead is put in, the horse is no longer capable of moving it.

If you have steam acting upon—that is, pushing—the piston of a locomotive, the latter being connected in the well-known way to a driving wheel, you have only to put more and more wagons—that is, a larger and larger load—on to the train to reach a point when the engine is no longer able to draw the train.

In both these cases you have a force overcoming a resistance, and you can easily see that a given force will only overcome a certain resistance. If the resistance is below the powers of the engine or the horse, then motion of the load takes place.

Dealing with an electrical circuit, you have a pressure overcoming resistance and giving rise to a current. As the resistance increases the current gets less and less, till past a certain resistance the current—which in this case is the equivalent of the motion in the other cases—ceases altogether. You will easily see that you can get little or no information about the horse's or engine's exertion when there is no motion, but in both cases you do learn something when there is motion—in fact, you have to consider both the load moved and the motion imparted to that load. So in electricity, if there is no current your measurement is at a standstill—you must consider both the resistance overcome and the current. The full force of the engine or of the horse may be exerted with too heavy a load, and may be measured by the interposition of a spring, but we cannot very well interpose a spring when electrical pressure is to be measured, so that although the mechanical measurements may help you to better understand the electrical ones, the likeness is not perfect. The use of a balance again helps somewhat to understand what we have to measure. Here are two scales. In one I put an unknown weight, which is pulled earthwards by gravity. I can exactly balance that pull by putting another weight or other weights into the opposite balance. The known weights are multiples or sub-multiples of an accepted unit, and thus we make our comparisons.

So in some such way we measure electrical pressure. As I have said, the unit adopted is called a volt; but we have no generator of electricity that always gives us an exact pressure of a volt.

Standard Cell—Some years ago Latimer Clark proposed a cell which is fairly constant, and which has been adopted as a standard. It is thus made: pure mercury is covered with a saturated solution of zinc sulphate made into a paste with pure Hg_2SO_4 (mercurous sulphate) and $ZnSO_4$ (zinc sulphate). Pure zinc plunged into this paste forms the negative pole, while a platinum wire fused through the bottom of the cell, or carried down into the mercury in a glass tube from above, is the positive pole. The element is sealed with paraffin. This element when carefully prepared is said to be correct to $\frac{1}{1000}$, but only for currents not exceeding 0·0001 ampere. At a temperature of 15deg. C. it gives 1·434 volts. According to Lord Rayleigh, at the temperature t it gives $1{\cdot}437 - 0{\cdot}001\,(t - 15)$ volts.

If, now, I have a battery which causes a current to traverse a given resistance 10 times larger than the current traversing the same resistance from a standard cell, then the pressure of the battery is 10 times that of the cell, or $1{\cdot}434 \times 10 = 14{\cdot}34$ volts at 15deg. C.

Another way to find the unknown pressure would be to add standard cells in series, so that the pressure from the cells was opposed to the unknown pressure. As the

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pressures would be opposed the current would be lessened, and when the pressures balance there would be no current. By counting the number of standard cells in series, and multiplying this number by the pressure of one cell, we should get the amount of the balancing pressure, which would be the equivalent of the unknown pressure. Of course this would be a cumbrous and ofttimes an impossible method of procedure, but I prefer you to understand the principles as well as to understand the practical methods adopted.

Current Measurement.—There are three ways in use by means of which we can measure an electric current :

1. By electrolysis.
2. By its magnetic action
   α, upon a magnet ;
   β, upon another conductor carrying a current.
3. By its heating properties.

By Electrolysis, matter is presented to us in one of three forms—solid, liquid, or gaseous. The chemical action of an electric current is generally confined to certain liquids and solutions, and to the process of decomposing a liquid by means of a current the term electrolysis has been given. Matter in whatever form presented, if it consists of one substance only, is said to be an element ; if it can be split up into several substances, it is termed a compound. You cannot split up an element, therefore you cannot electrolyse it. The liquids that can be electrolysed must therefore be compounds. They must also be conductors. From the electrolytic point of view, we may regard liquids as of three kinds :

1. Elements, such as molten iron, lead, etc.
2. Non-conducting compounds, such as various oils, resins, turpentine, benzine, etc., and probably *pure* water.
3. Conducting compounds, such as water, dilute acids, etc. ; solutions of metallic salts, as sulphate of copper, nitrate of silver, etc.

(To be continued.)

THE JANDUS ARC LAMP.

As mentioned in our last issue, this lamp is so designed as to preclude oxygen from reaching the arc. The result is that the carbons consume very slowly, saving much time in trimming and carbon renewals. This is by no means the first attempt to attain this end, but difficulties in detail have removed earlier rivals from the field.

The Brougham and André lamp, which was exploited in 1889, used the same principle. This lamp was one of that large class, now almost extinct, which were called semi-incandescent. In this lamp the light was obtained from the point of contact between a thin carbon and a large carbon or metallic block. A description of the lamp in the *Engineer* of March 12, 1880, says : "It was seen that if a carbon could be rendered incandescent in a vacuum or in some gas which would not combine with it, one source of waste would be prevented. Several inventors worked on these lines, and Mr. André, following in their footsteps, contrived to make a very good lamp. It was not quite perfect, but so far as can be judged from a lamp which we have seen in operation at the works of Messrs. Paterson and Co., the improvement effected by the Hon. R. T. D. Brougham will place it before any other lamp on this principle now in use. The value of the improvement will at once be seen when we state that it reduces the carbon consumption to about ·125in. per hour, whilst a similar carbon burnt in a lamp open to the atmosphere burns about 6in. per hour. The cost of carbons is thus reduced to one forty-eighth of what it would be in an ordinary lamp.

The improvement consists in surrounding the lamp, or a portion of it, with a separate vessel of glass containing water or some other suitable liquid—the glass globe of the lamp thus being surrounded by a second globe containing a liquid. In this way the liquid prevents any oxygen getting to the source of light, and that contained in the inner globe is soon converted into carbon dioxide."

Mr. William Jandus, of Cleveland, Ohio, has evidently been working on the subject *de novo*, as his first patent specification issued in England, and dated November 17, 1891, only claims a saving in carbon of 85 per cent. of the quantity used when the air has free access to the arc. At this time he used one globe only, and that was hermetically sealed at the top, but open at the bottom. In this way only the circulation due to convection was prevented, and the diffusion of air into the space doubtless aided the combustion of carbon. In this early lamp the form of the containing globe was similar to that of the inner globe in the present lamp (Fig. 1), but it was attached to the upper carbon-holder, and moved down as the lamp fed. In the drawing attached to the specification a Jablochkoff candle was shown in a completely closed globe. The next patent granted to Mr. Jandus is dated January 23, 1894, and contains the essential feature of the lamp now being placed on the market by Messrs. Drake and Gorham.

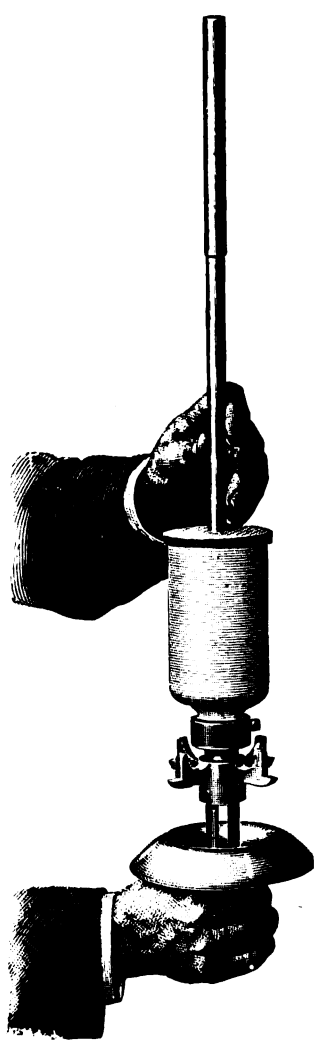

FIG. 1.—View showing the Method of Trimming the Jandus Arc Lamp.

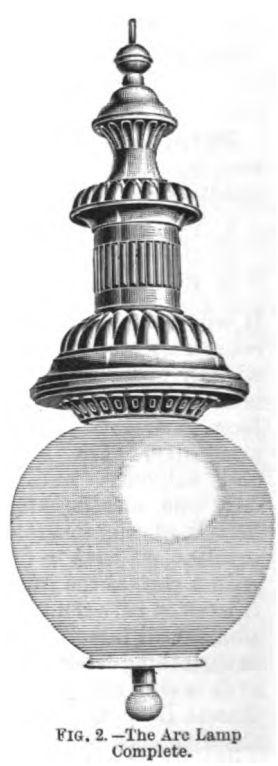

FIG. 2.—The Arc Lamp Complete.

The arrangement for keeping the arc surrounded by an inert gas has in this later Jandus lamp been arranged as follows: A small cylindrical globe surrounds the arc, as shown in Fig. 1. This globe rests on the casting forming the lower carbon-holder, and is roughly closed at the top by a metal plate, which, however, does not fit tightly round the upper carbon.

The outer globe (seen in Fig. 2) surrounds the whole, and is attached by an airtight joint to the upper part of the lamp. At the bottom there is an opening sufficiently large to enable a hand to be put in for the purpose of cleaning the globe, etc. This circular opening is closed by the saucer-shaped metal disc on the lower carbon-holder (Fig. 1). This is pressed against the globe by a spring, so that any rise of pressure of the gas inside the globe moves the disc and so is relieved. It does not absolutely prevent ingress of air to the globe, but as there is no other opening there can be no circulation. What happens when the lamp is switched on is about as follows : The arc quickly

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consumes the whole of the oxygen in the inner globe, and by the rise of temperature a considerable amount of air is expelled from the orifice at the bottom of the large globe. In a short time the air in both globes will be converted into a mixture of carbon monoxide, carbon dioxide, and nitrogen. It is probable from the conditions that carbon monoxide is the chief oxygen compound. In other lamps of the same make and principle, but which had not equally good arrangements for excluding oxygen, a considerable blackening of the globe has been observed. It is claimed by the inventor that when the gases in the inner globe reach a temperature of 600deg. F. this depositing action ceases. With certain carbons a whitish siliceous deposit is obtained, but by the careful selection of good carbons the Jandus lamp is free from the above defect.

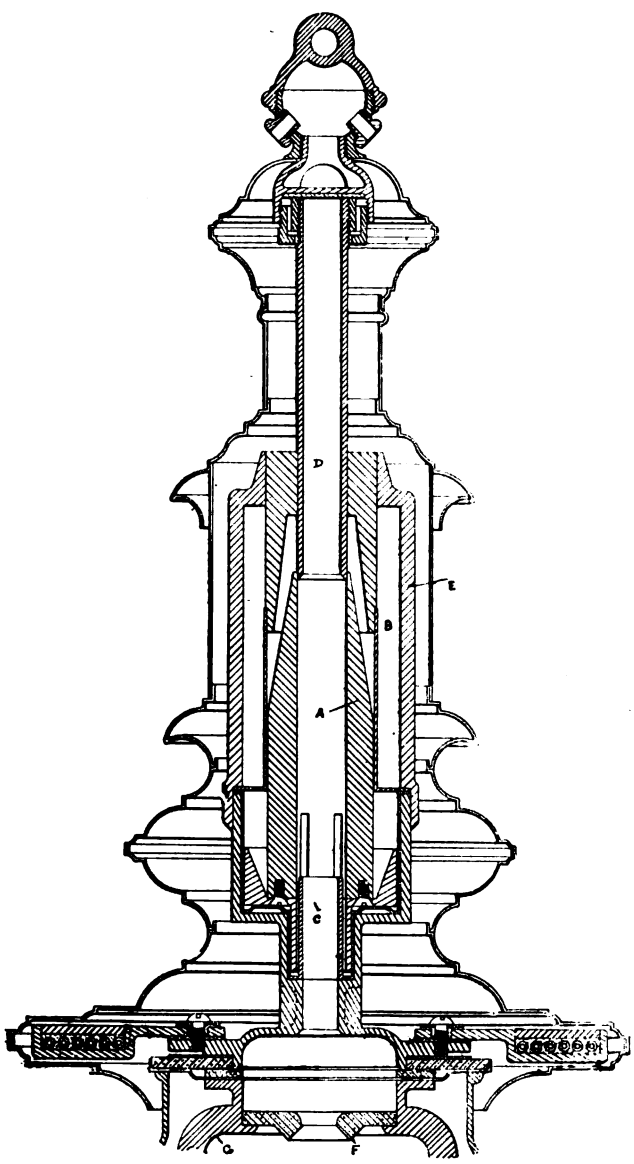

FIG. 3.—Section of the Jandus Arc Lamp Mechanism.

As would be naturally expected, new characteristics of the arc are found when burning in inert gases at high temperature. The current required to maintain a given length of arc is decreased, and there is no difficulty in keeping an arc $\frac{5}{8}$in. long with only five amperes flowing, but about 80 volts are required at the terminals. The ends of the two carbons do not then form into a point and crater respectively, as in ordinary direct-current arcs, but burn to flat ends the full diameter of the carbon. There are signs on the ends of the carbon that the arc is continuously moving round, but there is no hissing noise given off, as would be expected, and also no flare. The light given from the two flat-ended carbons $\frac{5}{8}$in. apart gives a different polar curve of intensity to that obtained with the arc in air. No definite measurements have been made up to the present, but Messrs. Drake and Gorham tried the following neat rough test: A strip of sensitised paper was fastened round a vertical segment of the globe for a short time. The same was done for an ordinary arc lamp having the same diameter globe. The two strips were then compared, and the intensity of the light in any direction could be seen approximately by the colour of the paper. It seems from this that the ray of maximum intensity is nearer the horizontal in the Jandus lamp than in the other types, but that the ratio between maximum and mean ray is less. In other words, the polar curve is not so peaked. The next point in issue is the question as to whether the old belief that the light given by an arc is roughly proportional to the current holds under the new conditions. Messrs. Drake and Gorham, from rough photometric tests, state that the light per watt is practically the same for the Jandus as for an arc lamp burning in the air with the same length of arc. Unfortunately, this is comparing the Jandus lamp in its most favourable condition with an ordinary lamp in abnormal conditions. The Jandus lamp, however, loses a large proportion of its light owing to the two diffusing globes. Therefore at the present time there is no evidence to show whether the lamp compares favourably or not with its older rivals in point of lighting efficiency. On the score of cost of trimming it is far ahead, as one pair of carbons will last some 200 hours, and doubtless this saves fully as much in labour as in cost of carbons. The details of the feeding mechanism are most carefully designed, and present many novel features. Fig. 3 shows a section of the lamp, but, unfortunately, the details of the feeding and self-centreing gear are incomplete. A is the moving armature of the electromagnetic system, E, which is all arranged concentrically with the upper carbon. The series and shunt winding come in the space, B, but are not shown in the section. The upper carbon, and the brass tube attached, which can be seen in Fig. 1, is pushed up the centre tube, C D. The end, C, of the lower fixed guide is cut away at the top, leaving four sections projecting. Between each of these a brass wheel is placed, which touches the inverted cone on the armature at either the carbon rod or the end of the tube, C. In the normal condition these wheels grip the carbon, but when the arc gets too long the armature lowers till the wheels touch the end of C, and thus relieving the pressure on the carbon, allows it to feed. A somewhat similar but even more ingenious self-centreing arrangement is employed, by which a series of rings supply current to the carbon, and at the same time centre it. This comes in the space above F in our illustration. The added resistance for the lamp is arranged round the rim of the case and can be seen in the section. The lamp normally takes 80 volts, so that about 20 volts is absorbed in this resistance when the lamp is worked on a 100-volt circuit.

The lamp with two diffusing globes gives a splendid light for interiors, where a glaring spot of light should be avoided.

THE ELECTRIC LIGHTING OF EDINBURGH.

BY HENRY R. J. BURSTALL.

(Concluded from page 476.)

ROADWORK.

Distributing Mains.—Practically the whole of the distributing mains are laid as cable insulated with indiarubber, heavily braided, drawn into Doulton stoneware casing under the footways, and into either Crompton-Davis cast-iron casing or cast-iron pipes under the roadways. At all crossings, and at intermediate places on the footways, brick junction-boxes are built for the purpose of drawing in, connecting, and testing, and smaller brick boxes are provided at suitable intervals, where connections are made to consumers; but for this purpose, when space is limited, a special length of Doulton casing is provided, which is so made that it can be easily split longitudinally and removed; the house connection is then made with vulcanised joints, and the casing replaced and jointed up with a special collar and bitumen cement. The collar is provided with a socket, into which the pipe carrying the house connection can be jointed. A mark is made on the kerb to indicate the position of the service box, and the pavement is then replaced. These service boxes are found to be of great use owing to the number of cellars under the pavement. The brick junction-boxes are covered with a cast-iron frame, which is fitted with a cast-iron cover filled in with concrete, a water tight joint being made with the frame. In most places the

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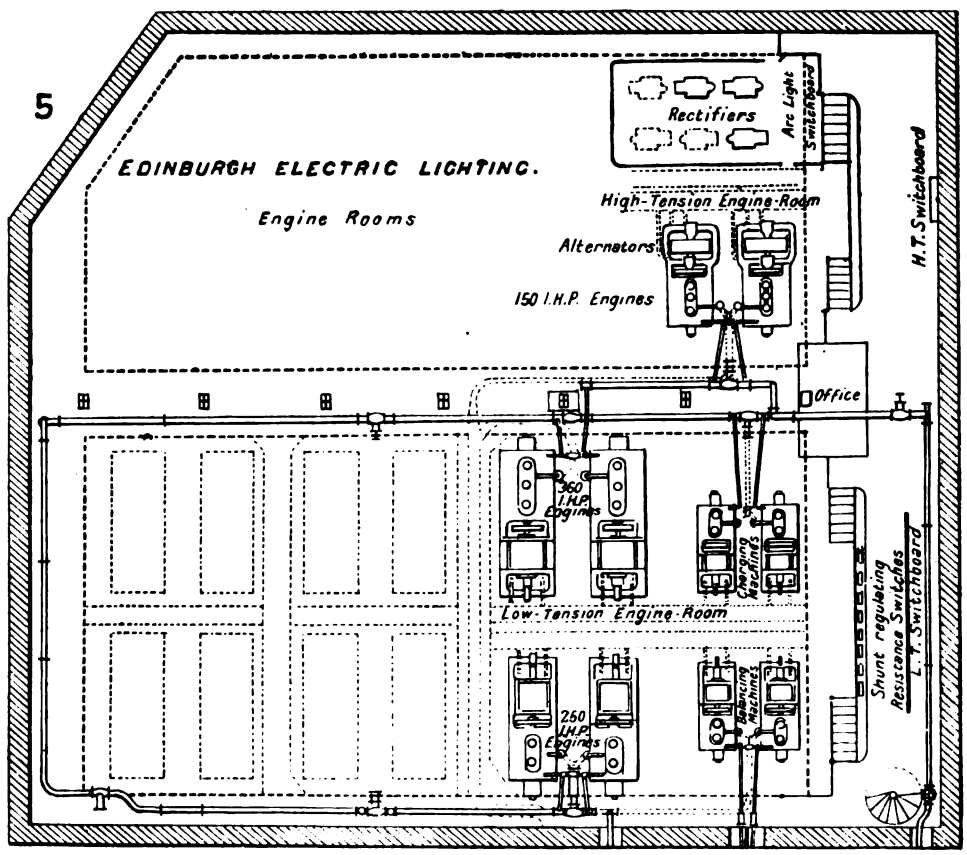
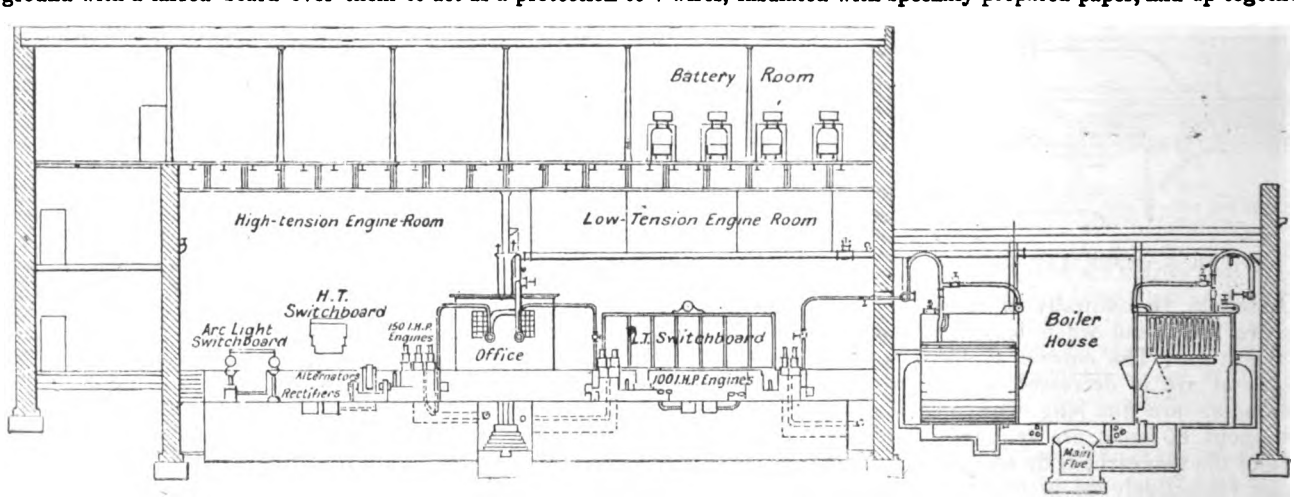
bottom of the box is filled in with dry rubble so as to form a drain for any water which may find its way in; but where water has been found in the soil the bottom of the box is concreted, and the whole made water-tight. Where it has been necessary in some places to put junction-boxes in the road they have been made as water-tight as possible, and covered with a double cover, the upper being a heavy cast-iron cover with wood blocks let into it. Boxes in the road have been avoided as much as possible, as it is found so difficult to make a satisfactory job of them. In a few places the distributing mains have been laid as bare copper strip, carried on stoneware insulators in concrete culverts.

Feeders.—Wherever sufficient space has been found under the footways, the feeders have been laid as bare copper strip, carried on stoneware insulators in concrete culverts. Across all roads, and where there has not been sufficient space for culvert, the feeders are laid in Siemens armoured cable, laid direct in the ground with a tarred board over them to act as a protection to them and as a warning to any workmen opening the ground. The cable has everywhere been laid of greater section than the copper strip in the rest of the feeder, so that the capacity of the feeder can be largely increased and yet the resistance be kept right by pulling in additional copper strip into the culverts without bringing the current density up to any excessive amount in the portions laid in cable. Thus the feeders can be made to carry considerably more current than that for which they are now designed, with the same drop of E.M.F., and without either disturbing the streets or overrunning any of the cables. All the feeders have been designed to have a total drop of 44 volts at full load. In the culvert the copper strip is laid in lengths of about 20 yards, with a brick inspection-box at each joint; so that the culvert can be easily seen by means of a lamp pushed into it, and the strip can be readily drawn out and in, as required. The joints are made by tinning the ends of all the strips, and clamping them together by a gunmetal grip-box with two ⅝in. bolts; at the feeding points the feeders are connected to the mains by short pieces of cable. Everywhere the culvert is kept quite straight in plan, but with a fall towards every junction-box or inspection-box. The strip is in no place lower than 2ft. below the level of the pavement; for it has been found elsewhere that it is impossible properly to inspect or do any work to culverts which are constructed at any great depth. There is nowhere any culvert under a roadway.



Plan of Engine-rooms.

Potential Leads.—These lines, by which each feeding point is connected back to the station, consist each of three sets of wires, insulated with specially prepared paper, laid up together, and covered with the same material, a lead tube being drawn over the whole. These leads are drawn into special ways, either in Doulton stoneware casing or cast-iron pipe, laid alongside the culverts, and are joined up into one length back to the station. The joints are made in a brass tube, soldered on to the lead sheathing, and containing insulating oil; the wires are kept separate from one another by fibre discs.



Section through the Edinburgh Electric Light Station.

Connections.—The whole of the cable connections are made by cone connectors sweated on to the cables, and fitting into gunmetal connecting-blocks. The cones are all the same size

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for all sizes of cable, and are interchangeable; when the section of cable exceeds 0·7 square inch, two cones are used; the taper employed is 1 in 11, which makes a good fit and is yet readily

of altogether 176 public arc lamps. In the streets dotted black the arc lamps are run four in series off the distributing mains shown by red lines, and each series of four is provided with a

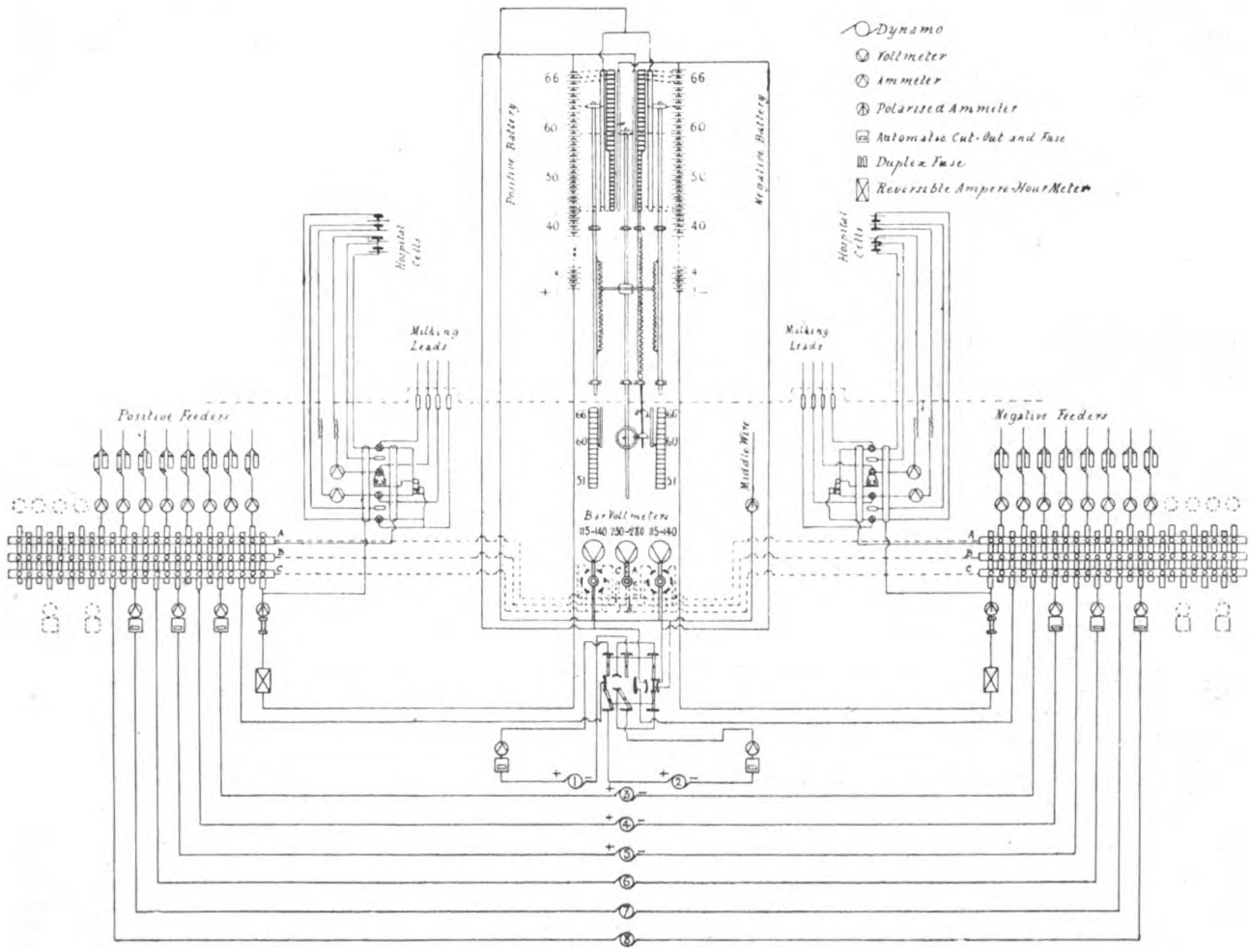
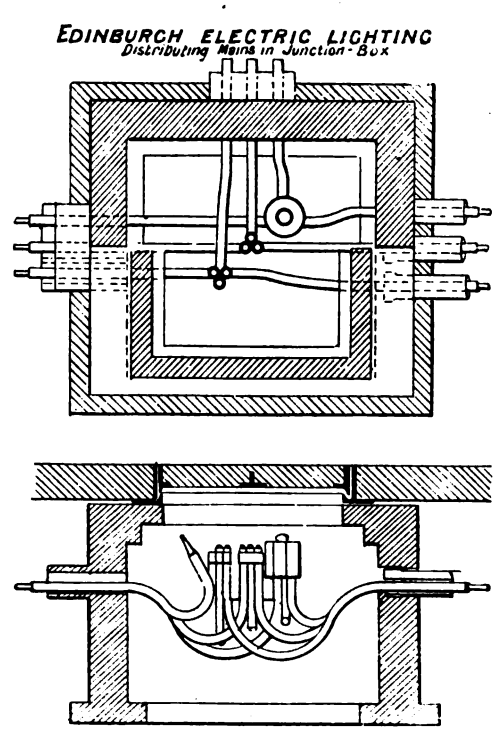
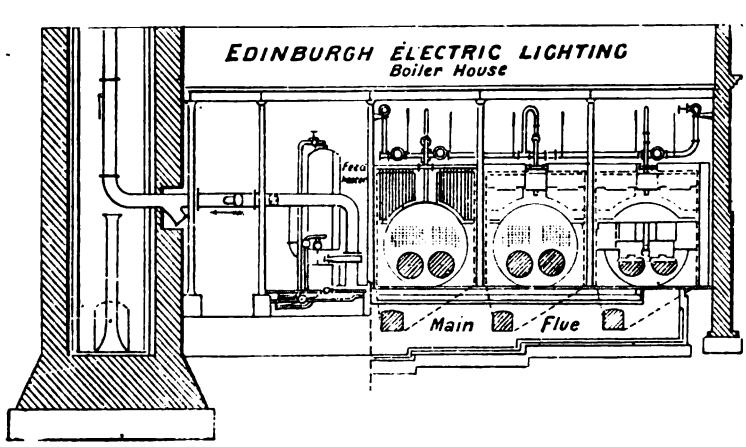


Diagram of Low-Tension Connections at Edinburgh.

disconnected. The cone connecting-blocks are made in four sizes, having two, three, four, or five holes bored in them. The holes are bored conical to fit the cones on the cable connectors, and the blocks are interchangeable with one another. The armoured cables, which are all of large section, have special connectors sweated on to them, and these have either one or two of the standard conical holes bored in them; the connections to the distributing mains are then made by one or more short lengths of cable having cone connectors at each end. Enough slack is left in the boxes to allow the ends of the cables to be turned upwards; they are then connected together by slipping the connecting-block on them, and the cones are drawn tight into the holes by means of a nut fitting upon a $\frac{3}{8}$in. screw on their ends. In order to obviate any trouble from end leakage through water dripping on the bare terminals, and also to minimise the risk of short-circuits through accidental contact

fuse, switch, and line resistance. Each lamp in the series is also provided with an automatic device, which, in the event of the lamp failing, cuts it out and introduces into the circuit a resistance equal to the lamp, so that the other lamps in that





Section of Boiler-house.

between the blocks, stoneware caps are dropped over the connectors, and entirely cover all bare metal.

Public Lighting.

The streets tinted on the map are lit by electricity, by means

circuit are not affected. The lamps in Princes-street are constructed for a normal current of 15 amperes, and all the other low-tension lamps for 10 amperes.

In the streets tinted purple, in which no low-tension mains are laid, the lamps are run on special high-tension series

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circuits from the rectifiers at the station. There are at present two series circuits, both of which are laid in all the streets lit by high-tension lamps, and the lamps are connected alternately to each circuit. The circuits are laid as concentric cable drawn into cast-iron pipes, the outer conductor of the cable being insulated. There are 24 lamps on each circuit, each provided with an automatic cut-out in case of its failing to act, and also with a switch in the pillar, by which it can be entirely disconnected from the circuit if necessary, while the switch is so made as to complete the circuit for the other lamps.

In arranging the circuits for the arc lamps, care has been taken to put alternate lamps on separate circuits in all streets, whether run from the distributing mains or from the series circuits. This minimises the risk of any street being left in darkness by the failure of any circuit; and also allows half the lamps to be switched off at or about midnight, still leaving the streets well lighted. The arc lamps are of Crompton-Pochin type, and are fitted with 18in. spherical globes. They hang from the bracket of a cast-iron pillar, the centre of the globes being 23ft. above the level of the pavement. In Princes-street the lamps are about 45 yards apart, and are on one side only of the street. In the other parts of the city the lamps are about 60 yards apart, and are placed alternately on the two sides of the street.

No contractor was employed for the roadwork or laying of the mains; the whole of this work, including the erection of the arc lamp-posts, was carried out by the resident engineer, Mr. E. W. Monkhouse, with his own staff of workmen. The armoured cables were supplied by Messrs. Siemens Bros. and Co.; the unarmoured cables by the Henley's Telegraph Works Company, and the India Rubber, Gutta Percha, and Telegraph Works Company, Silvertown. The potential leads were supplied by the British Insulated Wire Company. The stoneware casing was manufactured by Messrs. Doulton and Co., and the cast-iron work by Messrs. Maclaren and Messrs. Shaw and Co., of Glasgow. The copper strip was supplied by Messrs. Bolton and Co., of Oakamoor Works. The posts for the arc lamps were designed by the Edinburgh School of Art, and the castings were made by Messrs. Mackenzie Bros., of Edinburgh. The whole of the arc lamps were supplied and fixed by Messrs. Crompton and Co., of Chelmsford, who also supplied the cable cones and connectors.

In this account of the electric lighting of Edinburgh the author has endeavoured to describe the arrangement of the plant and mains, and any details in their design and construction which may be of interest, without discussing general principles or the advantages or disadvantages of any individual system. Having himself had the good fortune to be connected with this particular work from its earliest stage to its opening, he desires to express his deep indebtedness to Prof. Kennedy for permission to prepare the present paper and to use the drawings from which the diagrams have been enlarged; and also for his suggestions and assistance, without which it would have been impossible for this paper to be laid before the institution.

THE PORTRUSH AND GIANT'S CAUSEWAY TRAMWAY.

INSPECTOR'S REPORT.

The following is the report of Major Cardew on the enquiry held at Portrush on September 25 and 26, 1895, into the causes of a fatal accident to a person named Thomas Walne on the Giant's Causeway Tramway:

"To the Assistant Secretary, Railway Department, Board of Trade.—Sir: I have the honour to report that, as appointed by the Board of Trade, I held a local enquiry as above The enquiry was held in the Town Hall, Portrush, and occupied two days The complainants, on whose application the Board of Trade decided to hold this enquiry, are certain ratepayers of the district traversed by the tramway. Mr. William Moore, barrister (instructed by Mr. T. Taggart, solicitor) appeared on behalf of the complainants; Mr. W. H. Leech, solicitor, on behalf of the tramway company. Besides hearing statements and taking evidence, I carefully examined the line throughout, and the station where the electric power is generated. The tramway upon which the accident occurred is a line six miles in length, constructed under powers given by the Giant's Causeway, Portrush, and Bush Valley Railway and Tramways Act, 1880, between the town of Portrush and Bushmills, along the side of the public road, and an extension, which is more properly a railway, two miles in length, across private property, to a terminus in the immediate vicinity of the Giant's Causeway. The line is worked chiefly by steam-engines, but, in addition, electric motors are provided in a few of the cars, and electric power is supplied to these, except for the portion of the line within the town of Portrush, where steam power is used exclusively. The electric power is supplied from a generating station at some distance from the line by means of overhead wires, the energy being obtained from water power. The charged conductor, by contact with which the electric current is transmitted to the motors on the cars, is a stiff iron rail supported at a height of about 18in. from the ground on the side of the tram rails next the hedge or boundary of the road. At road crossings, and at gateways into fields, the conducting rail is omitted for the requisite length, and connection effected by means of an underground cable across the break of continuity. The return circuit is provided in the usual way by means of the tram rails, copper bond wires being used to connect together the several lengths of rail. No attempt has been made to secure the public using the road or cattle driven along it from contact with the charged conductor rail. The inspection was made on the afternoon of the 25th inst. I found that the regulations imposed by the Board of Trade had been disregarded in many particulars, as follows: Regulation V., entirely disregarded. Regulation VI., ditto. Regulation VII., I do not consider the voltmeter in use efficient for the purpose, as although it appeared to be approximately correct in its indications, it was far too small to be read conveniently at the distance at which the man stands to regulate the current Regulation IX., entirely disregarded. Additional regulation as to notices along the line insufficiently attended to. I only saw three such notice boards, and the inscription on these was almost obliterated. By-law IV. disregarded in the cars I saw. I took several tests of the electric pressure at the station at Bushmills, being the nearest point of the line to the generating station, and at the generating station itself. The volts on the line varied considerably, the highest reading I obtained being 310, and the average about 290. At the station the readings were much the same As the regulation was entirely by hand, I tested what would be the effect produced by ordering the attendant to leave the regulating wheel alone, as if he had been suddenly incapacitated Under these circumstances the pressure only rose to about 320 volts. The water was, however, rather low at the time, and at periods of full supply no doubt a greater rise of pressure might be produced; indeed, Mr. Boyd, the inspector to the tramway company, stated that the highest he had observed at any time at the generating station was 360 volts. The charged rail appeared to me to be a decided obstruction, especially at road crossings and in front of field-gates. It seemed to me hardly practicable for a man to drive a herd of cattle along the road, or into a field abutting it, without great risk of one or more animals receiving a shock.

"*Conclusion.*—Having carefully considered the evidence produced at the enquiry held by me, and the observations made at my own inspection, I am of opinion (1) that Thomas Walne died from the combined effects of severe injury caused by the fall across the rail and electrical shock; (2) that the tramways in question are at present, when the insulated rail is electrically charged, a danger to the public and an annoyance to the ordinary traffic; (3) that the Giant's Causeway, Portrush, and Bush Valley Railway and Tramways Company have not paid sufficient attention to the regulations imposed upon them by the Board of Trade. As to (1), I consider that the lethal effect of the electric current was due to the large extent of contact made by the body of deceased with the charged rail, the considerable pressure—viz., a large portion of the weight of a man nearly 13 stone—with which the contact was made, and the length of time (at least several minutes) during which the current was passing through his body. With regard to (2), it must, of course, be borne in mind that this electrical tramway was one of the earliest constructions of the kind. In my opinion, the danger that has undoubtedly existed has been largely due to the position of the charged rail at a height of about 18in. from the ground. Had this rail been placed at the ground level it would have been far safer than it is at present, while if it had been raised to a height of not less than 8ft. from the ground, and greater width of opening allowed at gateways and road crossings, I think that with proper regulation of the electric pressure the working of the line would have been practically free from danger. As at present arranged the charged rail is easily touched by man or beast, and the effect of the shock is exceedingly likely to cause a fall across the rail, which in itself must probably produce physical injury, and also such a contact of the body with the rail that the resulting electric current is large enough to cause death unless assistance should be given at once. With regard to (3), the tramway company allege that they have found a practical difficulty in complying with some of the regulations imposed upon them by the Board of Trade. There may be some grounds for this statement, but this difficulty should have been brought to the notice of the Board of Trade with a view to the modification of these requirements, and even this excuse does not extend to all the failures on the part of the company to comply with regulations.

"*Recommendations.*—I recommend that the tramway company should be required, under the provisions of Section 20 of the Act of 1880, to remove without delay the danger and annoyance to the public which have been proved to result from their existing arrangements by adopting one of the following (three) remedies—viz.: (1) To remove the existing charged rail altogether and adopt an overhead system, in which case the limit of electrical pressure might be reconsidered. (2) To raise the existing charged rail to a height of not less than 8ft. from the ground. (3) To effectively protect the existing charged rail, as suggested by the complainants. This expedient, however, appears to me to be difficult to carry out, and in all respects the least desirable of the three. The tramway company should also be required to exhibit in a conspicuous position at their Bushmills station an efficient and correctly indicating voltmeter connected to show the electrical pressure at this point of their line, and it is desirable that this should be arranged to make a continuous record, but in any case its indications must be clearly visible to the public. Further, the tramway company should be called upon for a full explanation of the failure on their part to

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comply with the regulations made and imposed upon them by the Board of Trade. In the meantime, I think the company, having regard to the danger which has been shown to exist, should discontinue their use of electrical power until they have carried out the alterations decided upon, working their line entirely by steam power for the present."

LEGAL INTELLIGENCE.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.

In the First Court of Appeal (present, the Lord Chancellor, the Master of the Rolls, and Lords Justices Kay, Lopes A. L. Smith, and Rigby), application was made in the case of the South Staffordshire Tramways Company *v.* Ebbsmith and Wain for leave to appeal from an order of Mr. Justice Hawkins refusing to the plaintiffs' inspection of the bank books of the defendant Ebbsmith and of the Dickinson Tramways Appliances Company. The claim alleged as against Ebbsmith was that during the seven years in which he acted as solicitor for the plaintiff company he sold at exorbitant prices worthless patents to the plaintiff company without disclosing the fact that the Dickinson Tramway Appliances Company, which was nominally selling the patents, was, in fact, himself; that he sold land to the plaintiff company which it could not use under its articles of association; and that by means of shareholders created by himself meetings of the company were influenced, and the plaintiffs claimed a return of secret profits alleged to have been made by the defendant while he was in a fiduciary position towards the company. Application was made to Mr. Justice Hawkins for leave to inspect the banking accounts of Ebbsmith and the Dickinson Company, to see what moneys had been paid to Ebbsmith and the defendant Wain, the chairman of the defendant company. This leave was refused, and permission was now asked to appeal. Their Lordships acceded to the application

CLAIM FOR ELECTRIC LIGHTING.

In the Brompton County Court on Friday, before his Honour Judge Stoner, the case of Sabow *v.* Barwise, in which the plaintiff, an electrical engineer, sought to recover the sum of £12 18s. 6d. in respect of electric lighting work done to the order of the defendant.

It appeared from the evidence that the plaintiff became acquainted with two men named Silvester and Foster, who told him that they could introduce business if he would pay them for so doing. It was ultimately agreed that the plaintiff should find the necessary fittings, and that Silvester and Foster should do the practical part of the work, at a fixed rate of 8d. per hour and a share in the profits. The work in question was carried out under that arrangement, but upon application for payment being made to the defendant, it was discovered that he had paid the account to Silvester and Foster. It was contended that the defendant had no authority to pay anyone but the plaintiff, and if he chose to do so it did not rid him of his liability.

The **Defendant** was called, and said he never saw the plaintiff in the matter at all, and never recognised him The order was given to Silvester, who held himself out as principal, and upon the work being completed the account was paid to him

His **Honour** said it was pretty clear to his mind that there was fraud on the part of somebody. It was a hard case for the plaintiff, but under the circumstances there must be a non-suit.

SABOW v. BENSON.

This was a similar claim, arising out of precisely the same circumstances, but without going into the details his Honour entered a non-suit, and told the plaintiff that if he could prove fraud against his workmen he had better prosecute.

E. E. RIES AND A. H. HENDERSON v. THE METROPOLITAN TRACTION COMPANY, OF NEW YORK, AND THE METROPOLITAN RAILROAD COMPANY, OF WASHINGTON.

Messrs. Elias E. Ries, of Baltimore, Md, and Albert H. Henderson, of Philadelphia, Pa, have instituted legal proceedings against the Metropolitan Traction Company, of New York, and the Metropolitan Railroad Company, of Washington D.C., respectively, for infringement of certain letters patent relating to underground conduits for electric railways. The bills of complaint were filed in the Circuit Court for the Southern District of New York on September 17, 1895, and in the Circuit Court for the District of Columbia on October 3, 1895, respectively, through complainants' counsel, Messrs. Price and Steuart, and Mr. James Steuart, solicitors.

It is alleged by complainants, in substance, that the electric conduit railway line recently constructed for the Metropolitan Traction Company and now in regular operation on Lenox-avenue, New York City, as well as the underground conduit railway built by the Metropolitan Railroad Company and in operation on its Ninth-street line in Washington, D.C., severally constitute a direct infringement and violation of certain basic letters patent granted to Mr. Elias E. Ries and owned by the complainants, covering essential features which are used in the construction of the roads in question, and upon which their practicability and successful operation depend.

The patents upon which suit has been brought, and which it is alleged are infringed, are seven in number—as follows: 388 566, granted March 23, 1886 conduit for electric and cable railways; 370,283, granted September 20, 1887, underground conduit for electric and other railways; 383,770, granted May 28, 1888, underground conduit and collectors for electric railways; 386,085, granted July 10, 1888, electric railway; 386,087, granted July 10, 1888, combined electric railway and wire conduit; 409,756, granted August 27, 1889, electric railway crossing; 409,755, granted August 27, 1889, underground conduit for electric railways.

WESTERN ELECTRIC COMPANY v. THOMSON-HOUSTON COMPANY.

The United States Circuit Court of Appeals at Chicago on October 8 handed down, among others, an opinion adverse to the Thomson-Houston arc regulator The Thomson-Houston Electric Company was the unsuccessful party in the suit. The action involved a device known as the automatic regulator, which, as to arc lighting, performs a function similar to that of a governor on the steam engine

Suit was begun against the Western Electric Company, praying for an injunction restraining the defendant company from using the regulator and asking for an account The suit came to trial before Judge Grosscup in June, 1894. The Court upheld the contention of the Western Electric Company that the second patent, which it was claimed was being infringed, was voided, because of the prior issue of the patent covering the device An appeal was taken to the United States Circuit Court of Appeals, which affirmed Judge Grosscup's ruling.

COMPANIES' MEETINGS AND REPORTS.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.

The ordinary general meeting of the Brazilian Submarine Telegraph Company, Limited, was held on Wednesday at Winchester House, E C., Sir John Pender, M.P., presiding.

The **Chairman**, in moving the adoption of the report, pointed out that it showed a steady growth in the telegraphic business. As traffic grew, the directors felt it their duty, when circumstances permitted, to reduce the rates, and the reduction which had come into force since the rate per word was introduced had been very large. The rate to Pernambuco was 9s. a word, it was now 3s. 6d. That to Rio was 13s., to Uruguay 16s 8d., to Argentina 16s. 4d.; they were now 4s. 6d. Those to Chili and Peru were 21s. 4d. and 21s. 6d. respectively; they were now 6s. 2d. That showed that while the Company had been progressing and doing a fairly good business, they had also regarded the people who were contributing to their business. The expenditure showed a decrease of £15 643, due to the absence of any heavy cable repairs. The position with the Brazilian Government was not satisfactory, and he thought that that Government should have shown more consideration for them as the pioneer Company which had helped to build up Brazilian trade by bringing the country into telegraphic relations with the commercial world. It was when they found that the Brazilian Government would not deal fairly with them that they tried to find means to carry on the traffic with Argentina. They had laid a cable across the Andes in conjunction with the West Brazilian Company, and were working that cable and doing a large business. To prevent the Brazilian Government interfering with that traffic they looked out for a fresh station, and pitched upon the Island of Trinidad, which was unoccupied except by land crabs, and which would make an excellent station They had, therefore, asked the British Government to enquire into the ownership of the island, and if it was unclaimed to take it. The Brazilian Government were trying to make a political question out of it, but the Company had no objection to Brazil having the possession of the island if they permitted the Company to use it as a telegraph station.

Mr. J. D Pender seconded the resolution, and the report was agreed to.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.

The ordinary general meeting of the Eastern Extension, Australasia, and China Telegraph Company was held on Wednesday at Winchester House, E.C.

Sir J. Pender, M P., presided, and, in moving the adoption of the report, said the great increase in the receipts during the period under review was almost entirely due to the heavy gold-mining traffic that had so suddenly sprung up with West Australia. Whether the remarkable boom would continue remained to be seen, and, all circumstances considered, it would, perhaps, be wise for him to say but little on the subject. The working expenses, including £29,322 for cost of repairs to cables and expenses of ships, absorbed £95 254, against £80 295 in the corresponding period of 1894. The usual interim dividend at the rate of 5 per cent. per annum had been paid, and a balance of £70,504 carried to the reserve. The shareholders, he thought, would agree with the directors that the affairs of the

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Company were in every respect in a satisfactory condition. They had reason to be satisfied with their dividends, and the carrying forward of a largely increased reserve fund was an eminently satisfactory feature in the working of the Company. Their plant was in excellent order, and the working of the Australasian tariff arrangement for the fourth year of guarantee, ended April 30 last, resulted in the guarantee figure being slightly exceeded, owing to the exceptionally heavy gold-mining traffic to which he had referred. The development or otherwise of the traffic would be watched carefully by the directors, as would all other matters affecting the interests of the shareholders.

The **Marquis of Tweeddale** seconded the adoption of the report, which was unanimously approved.

AMAZON TELEGRAPH COMPANY, LIMITED.

The first ordinary general meeting of this Company was held yesterday at Winchester House, E.C., Mr. W. S. Andrews presiding.

The **Chairman** said this was simply the statutory meeting, and they had no report or accounts to present. The Board were informed that 119 miles of cable had been already manufactured, and the whole of it was expected to be completed by the end of November. Their expedition would start shortly after that, and they hoped to see their line in full working order pretty early next year. So far as they had gone, their work had been very satisfactorily done by Messrs. Siemens, and they would have a thoroughly good cable and the best and most modern apparatus. The contractors' and the Company's engineers had been up the Amazon and fixed the points for landing the cable and erecting offices and quarters, and the Board expected to have a report from them in about a fortnight. A Stock Exchange quotation had been applied for, and the delay in obtaining it was due to it having been necessary to send certain documents to Rio Janeiro in order that the signatures should be attested by the British Consul there. When these came back everything would be in order.

Mr. Griffiths asked whether, as they had a subsidy from the Government, a dividend could not be paid during the period of construction.

Mr. Cuthbert Quilter, M.P., remarked that advances had been made in the direction of better relations between Brazil and foreign countries, and the amnesty which had been granted to participators in the late revolt would, he hoped, be the close of a very unhappy drama, and would be followed by a period of quiet and prosperity. Until their work was complete they could have no reliable estimate of what the value of their property was, and it would not therefore be prudent on the part of the Board to saddle the undertaking with interest paid during construction, which must, after all, come out of the concern.

The **Chairman** said that, although it would date back to the time of the contract, their subsidy would not be paid until the work was complete, and therefore, being under the Joint-Stock Companies Act, they could pay nothing until then. He concurred with what had been said as to the progress of better feelings between Brazil and this country, though these had certainly been affected by the dispute as to Trinidad. He might remark that, although their cable was called a river cable, the Amazon was not an ordinary river, as at Manaos, where their line terminated. it was 10 miles broad, and in time of floods 30 miles. The only really riverine portion of the route was where the Amazon fell into the Pará.

Mr. Cuthbert Quilter suggested the employment of telephones for working their branch lines, as the climate of Brazil was trying for European operators.

The **Chairman** said their representative in Brazil was enquiring into the matter. Native Brazilians, if properly trained, made very good telegraphists. Nevertheless, they had already ordered several telephones for their branch lines with a view to minimise the use of skilled labour.

There being no resolution, the meeting then terminated with the usual vote of thanks.

MONTE VIDEO TELEPHONE COMPANY.

A general meeting of this Company was held yesterday at Winchester House, which passed the report and accounts, an abstract of which was published in our last issue.

ELMORE'S PATENT COPPER DEPOSITING COMPANY.

The directors report that the profit on the last year's manufacturing account is £4,587, and after writing off the Company's general and trading expenses, the trading account shows a net profit of £2,253 carried to the credit of profit and loss, as against a loss of £6,858 in the previous year. This improvement has been effected without any increase in the Company's very inadequate working capital, out of which £5,202 has had to be spent in necessary additions to plant and buildings. The additions to plant are specially valuable, and are working very satisfactorily. Early in the year the Board decided to convert into a more readily realisable form a considerable quantity of old manufactured stock on hand at June 30, 1894, unrealisable immediately as such, and the consequent loss has been eliminated from the year's profit and loss account. The amount, £3,571, after deducting £625, balance of the sheet license royalties in hand, has been added to the balance of deficiency shown at June 30, 1894. Credit as heretofore is taken in the profit and loss account for £1,250, being the amount of license royalties applicable to the year. Of the managing director's salary, £200 has been charged to capital in respect to the new buildings and plant designed and erected by him for the company. The orders received have increased from 706 in the preceding year to 1,531 in the present year—more than double—whilst the deliveries to customers have been nearly four times greater in volume and practically three times larger in value, notwithstanding that the average selling price has been over £12 per ton lower. This diminution in price is, of course, quite beyond control. It is, however, satisfactory to note that prices are again ruling higher. Comparing the last half-year with the first, the aggregate deliveries to customers to June, 1895, were over three times as large as those to December, 1894. The working expenses show a remarkable decrease with the increase in the business done; in fact, the rate of manufacturing cost has fallen by over 50 per cent. The profit and loss account shows a net profit for the year of £480. That the amount is not larger is chiefly due to two causes—first, to the comparatively small scale of the Company's manufacturing operations owing to its restricted means, as before raising further capital the directors were desirous of proving whether or not the Company could make a profit even under the most adverse conditions; and, secondly, to certain annual charges entailed upon the Company under former administrations in respect to liabilities which are not properly within the sphere of an industrial company, which encroach very seriously indeed upon the profit arising from the Company's trading. The business has now reached a stage when further capital can be reasonably asked for and profitably employed in its extension. The shareholders will, therefore, be asked to increase the Board's borrowing powers, which are now so largely taken up by the land mortgage — not contemplated when the articles were originally drawn, limiting the borrowing powers to £50,000—as after borrowing £35,000 on the freehold, only a small margin is left. Power to borrow, therefore, as may be required, up to £100,000 will be asked for, and the debentures proposed to be issued will in the first place be formally offered to the shareholders. A resolution will also be proposed to reduce the ordinary share capital from £2 to £1 per share. This reduction of capital has no practical disadvantage whatever for the shareholders (as it is intended to arrange with the holders of the preference shares that their interest in the surplus profits shall not be increased at the expense of the ordinary shareholders), but, in fact, affords a distinct gain. The reduction will enable the Board to severely write down the capital value of some of the assets, and so diminish the annual charge on future profits for depreciation, and especially it will wipe out entirely the accumulated loss of past years, which would otherwise have to be cleared off out of profits before any distribution could be made to the shareholders, but, by thus reducing the capital, the old loss will no longer appear in the accounts, and the profits can be divided at once as they are made. Moreover, nearly the whole of the proposed reduction has already been returned to the shareholders in dividends.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Ceva (Italy).—The Municipality of Ceva, Mondovi-Cuneo, invite offers for lighting the town by electricity. Address, Il Municipio di Ceva.

Saarbruck.—Tenders are invited by November 15 for the supply of 1,500 telegraph posts. Conditions, etc., for one mark from Die Eisenbahn-Telegrapheninspection, Saarbrücken, Germany.

Lisbon.—Tenders will be received up to November 13 for the supply of various spare electrical machinery, for the Portuguese Royal Railway Company. Conditions, etc., at Paris, rue de Châteaudun, 28.

Kassel.—The Fulda Canalisation Direction invite tenders for the supply of six automatic water-level indicators, with electric alarms. Pneumatic apparatus preferred. Particulars from and tenders to Das Hauptbauamt der Fuldakanalisirung in Kassel, Lutherstrasse 5, II.

Guernsey.—The Guernsey Railway Company, Limited, invite tenders for two electric motor bogie cars, with top transverse seats and reversible backs, to seat 80 persons, and suitable for the overhead wire system. Particulars can be obtained on application to the secretary, Guernsey.

Madrid.—The Director of Public Works invites tenders by November 15 for the concession of the construction and working of a tramway from Madrid to Colmenar Viejo, with branches to Chamartin and Rosa. Security, 12,505 pesetas. Particulars at the Direccion General de Obras Publicas (Ministerio de Fomento), Madrid.

Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

Christiania.—The Secretary of State for Foreign Affairs has received information to the effect that the electrical works at Christiania require tenders for coal, either 2,000 tons best coal or 1,000 tons each of best gas coal and smokeless coal. Dates and conditions of delivery may be seen at the Commercial Department of the Foreign Office between the hours of 11 and 6, and further

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details can be obtained at the office of the electrical works in Christiania, where tenders must be delivered before November 5.

RESULTS OF TENDERS.

Paris.—For the supply to the Direction Générale des Postes et des Télégraphes, Paris (accepted tenders) :—(1) 80,000 porcelain insulators : M. Defuisseaux, Baudour, Belgium, 40,624f. ; (2) 80 000 *id.* : Mme. Vve de Fenoyls, Ste-Foy-l'Argentière, Rhone, 40,680f.; (3) 150,000 insulators and 20,000 pieces for sheeted insulators : MM. Hache et Cie., Vierzon, Cher, 43,400f. ; (4) 32,000 cast-iron insulators : M. Letixerand, Persan-Beaumont, Seine-et-Oise, 15,360f.

BUSINESS NOTES.

Newcastle-on-Tyne.—The Corporation have finally decided on the cable system for the tramways.

River Plate.—The United River Plate Telephone Company have decided to extend its system to the town of San Martin.

Tokio.—Three petitions for permission to lay electric tramways in the city of Tokio are in the hands of the Japanese authorities.

Glansur, Limited.—This Company has been registered. Object : to carry on business as rubber manufacturers, cycle makers, metal founders, toolmakers, etc.

Indo-European Telegraph Company, Limited.—The directors have declared an interim dividend for the half-year ended June 30 at the rate of 5 per cent. per annum, tax free.

Oldham.—The minutes of the Electric Lighting Committee show that the Local Government Board have sanctioned the borrowing of £15,000 for electric lighting purposes.

Metropolitan Electric Supply Company, Limited.—The transfer register will be closed from to-day to the following Friday, both days inclusive, for payment of an interim dividend.

Rhyl.—A meeting of ratepayers has protested against the proposal of the Corporation to expend a sum of £20,000 on the building of tramways in the town, the motive power to be either gas or electricity.

Catalogues.—We have received from Messrs. J. Halden and Co., of Manchester and London, their new illustrated drawing-office catalogue of instruments, drawing papers, tracing papers, and photo papers.

Fulham.—The Electric Lighting Committee of the Vestry will hold a meeting on November 7 for the purpose of interviewing candidates for the post of adviser to the Vestry in the matter of electric lighting.

Bath.—The electric lighting company have applied for the consent of the Council to their application for a provisional order to extend their circuit of supply in the city, but the Council declined to grant it.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended October 27 amounted to £1,075, as compared with £901 in the corresponding week of last year, being an increase of £174.

Manchester.—It is proposed to ask the Board of Trade for an extension of the area of supply for electric lighting purposes and to let one portion of the work be regarded as compulsory and another part as permissive.

Compagnie de l'Industrie Electrique, Geneva.—The financial year 1894 95 closes with a loss of 192,000f. This, added to last year's loss of 276,000f., shows that the Company is behind to the extent of 468,000f. with a capital of 2 500,000f.

Budapester Strassenbahn Gesellschaft.—This Company has resolved, in order to cover the cost of the conversion of its horse tramways into electric tramways, which will be 10,660,000fl., to issue new debentures and shares to that amount.

Bristol.—It has been decided that telephonic communication between the haven-master's office at Shirehampton and the dock-master's office at Cumberland Basin shall be at once provided, and that the National Telephone Company shall do the work.

Light Railways in Cornwall.—A scheme for a light railway between Callington and Saltash, at the Devon end of Cornwall, is being talked of, to be worked by Great Western rolling stock. The estimated cost of the new line is between £50,000 and £60,000

Mica Product Syndicate, Limited.—This Company has been registered with a capital of £30,000 in £1 shares. Object : to enter into an agreement, made August 30, with H. Boyd for the acquisition of certain undescribed inventions, and to develop and turn to account the same.

The Eastern and South African Telegraph Company, Limited, notify that on Friday, November 15, at noon, at the company's offices, Winchester House, Old Broad-street, E.C., 381 5 per cent. mortgage debentures will be drawn for payment on January 1, 1896.

Theatre-Lighting.—The Lyric Theatre, Bath, and the Empire Theatre, Bristol, have been fitted throughout with the electric light by Messrs. Vaughan and Brown, Limited, of London, E.C. The same firm have also done all the gasfitting and hot-water work at the above.

Ramsgate.—The work of telephonically connecting the coast-guard station on the cliffs at Ramsgate with Ramsgate Harbour has been completed by the Government. The object is to enable information of disasters on the Goodwins to be more speedily communicated to Ramsgate tug and lifeboat.

Crewe.—The Town Council have received many complaints as to the inefficient character of the telephone service, and a resolution has been passed asking the company to improve the service, or the Corporation would consider the question of giving them notice to take up their poles from the streets.

City and South London Railway.—The returns for the week ended October 27 were £977, compared with £948 for the corresponding period of 1894, being an increase of £29. The total receipts for the half-year 1895 are £14,678, compared with £14,811 for the corresponding period of 1894, being a decrease of £133.

Stapleton (Glos.).—The Urban District Council have discussed the question of public lighting. It was urged by several members that the adoption of electricity in place of gas would be advantageous not only from the point of view of efficiency, but also of economy. It was ultimately decided to refer the consideration of the question to a special committee.

Aylesbury.—The Urban District Council have receive a report from committee recommending that the clerk should ascertain the mode of procedure necessary to obtain a license to light the public streets by electricity, and, after discussion, it was decided that a meeting of townspeople should be called for the purpose of taking into consideration a proposal of applying for a provisional order.

Western and Brazilian Telegraph Company.—The directors, after placing £7,876 to the debenture redemption fund and £5,000 to the reserve fund, propose a half-yearly dividend at the rate of £2. 10s. per cent. per annum, leaving £5,803 to be carried forward. This dividend will be payable as follows : 3s. 9d. per share to the ordinary shares and 3s. 9d. per share to the preferred ordinary shares.

Personal.—A presentation was made the other evening to Mr. J. A. Bell, of the Blackpool electricity works, on the occasion of his marriage to Miss Emma Smith. The gift took the form of an elaborate case of Sheffield cutlery, and an artistic testimonial signed by all the workmen in the place, the work of Mr. E. Slater, of the electricity works. Mr. John Hesketh made the presentation on behalf of the staff.

Bangor (N. W.).—A special meeting of the Bangor City Council has been called for the consideration of matters relative to the proposed introduction of the electric light into the town. One of the principal subjects under discussion will be the question of authorising Mr. Medhurst, the electrical engineer who is advising the Council, to proceed with the preparation of the plans, etc., in connection with the proposed scheme.

Londonderry.—The Lighting Committee have received the report of the resident electrical engineer (Mr. Christie), in which it was stated that the Harbour Commissioners had accepted the terms of the Corporation for the lighting of the cattle-pens with three electric lamps. The terms are 10 per cent. on the capital expended (estimated at £120), and 3d. per hour per lamp, or 9d. per hour in all. The cable is being specially made, and will be in Derry about November 5, and the lamps will be put up as soon as possible afterwards.

Bridlington.—A company has been formed for providing a promenade, gardens, concert and dancing hall, club, dining-rooms, etc. In addition, it is intended to lay out Hilderthorpe Lodge and grounds as strawberry and tea gardens, with athletic ground, bowling-green, etc. The whole of the gardens and buildings will be amply lighted by electricity and gas, after the style of the Spa at Scarborough. It is proposed to lay down electric tramways from Hilderthorpe Lodge to the railway station, and possibly to Flamborough.

Leicester.—The Town Council have discussed a report of the Gas and Electric Lighting Committee with respect to a memorial addressed to the Council by the electrical engineers of the town praying that the gas department should not carry on a fittings branch in opposition to private enterprise. The committee recommended that there be no alteration made in the present practice of the department, and it was denied that the committee canvassed for orders for the fittings, but when requested by customers to undertake the work they did so.

Akkumulatoren-Fabrik Aktien-Gesellschaft, Hagen.—The turnover for the past financial year has reached 4,880,000 marks, compared with 4,090,000 marks in the previous period; and the number of installations carried out has increased from 3,000 to 4,000. The most important installations were as follow: Germany, 13; Austria Hungary, 11; Switzerland, 6; Denmark, Sweden, Norway, Holland, North America, and Africa, one each. The net profit is 630,239 marks (1893-94, 629,113 marks), with which a dividend of 10 per cent., as in the previous period, will be paid.

Sheffield.—The following resolution has been passed by the Parliamentary Committee of the Corporation : "That, considering the great importance of the tramways question, this committee consider it undesirable that any report as to taking over and working the tramways by the Corporation should be presented to the Council until after the appointment of the new Parliamentary Committee on November 9 next, but that the town clerk be authorised to give the necessary parliamentary notices for acquiring powers to work the same, and for the construction of such additional lines as may hereafter be decided on."

Light Railways for Anglesey.—Mr. Lewis Hughes moved at the County Council meeting that the Government be approached with a view of ascertaining what assistance they could render towards constructing a light railway from Valley to Amlwch. He suggested that a small and influential committee be appointed to meet the

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landowners of that district with a view to buying land on easy terms Both the last and present Governments had taken and were taking interest in light railways. Let the Council approach the present Government. Mr. Jones said that the committee, when appointed, should take the whole of the island into consideration. The motion was adopted.

London County Council.—The engineer having informed the Electrical Committee of the London County Council that he required additional assistance in consequence of the large amount of work at present devolving upon the electric lighting staff of his department, especially in connection with the inspection of electric light installations at theatres and music halls, the examination of proposals for loans to vestries and district boards for electric lighting works, and the lighting of the Blackwall tunnel, the committee have recommended that the engineer be authorised to engage the services of a temporary assistant for a period of three months at £3 3s. a week.

Edinburgh —Councillor Mackenzie, convener of the Electric Lighting Committee, believes that the electric light will be much cheaper than expected, because it is being taken more advantage of than was anticipated. Prof. Kennedy, in the report got from him in 1893, expected that within the first two years of the installation there would be from 20 000 to 25 000 8-c.p lamps on the system. The system is only six months old, and the Electric Lighting Committee have already got over 30,000 joined on. As the number is rapidly increasing, Councillor Mackenzie says the probability is that within the next year or two the charge of 6d. per Board of Trade unit will be reduced to 5d , if not less.

Cupar.—Mr. Gilmour (convener) has reported to the Fife County Council that the telephone company had agreed to pay to the county at the rate of £150 per annum, as from Martinmas, 1894, for poles and wires on the highways in the landward part of the county till January 1, 1896, when it is expected they would be taken over by the Post Office. The use of five instruments is to be continued for the county at £53 10s. per annum. Mr. Glass said, as a member of the Telephone Committee, that Mr. Haig, the convener, deserved the greatest credit for what he had done in the matter, and every member had worked earnestly to get the biggest possible payment that could be made to Fife from the telephone company, but they had been greatly misled.

The Central London Railway.—The work of constructing subways beneath the space opposite the Mansion House in connection with the new underground railway will shortly be commenced. The Bank of England authorities have requested that before these subways are commenced an examination of the foundations of the Bank at the corner of Princes street and Threadneedle street should be made. Arrangements are being made for sinking a shaft at this point, and in order that its construction may not interfere unduly with the pedestrian and vehicular traffic the work will be executed between the hours of 8 p.m. and 8 a m. Plans have been submitted, and will be carried into effect by Sir Benjamin Baker, Sir John Fowler, and Mr. J. H. Greathead.

Lancaster.—The Electricity Supply Committee have reported that Mr. A. S. Barnard had resigned his office of electrician to the Corporation, consequent upon his appointment to a similar office under the Corporation of Hull, and they had resolved that Mr. C. M. Johnson, assistant electrician, be appointed electrician at the electricity works on probation for a period of three months, at a salary of £100 per annum, he to perform such duties as the committee may from time to time determine, and to act under the instructions of the borough surveyor. On the report coming before the Council for confirmation it was suggested by the Mayor that, if at the end of the three months, the committee were satisfied with the appointment it would be a wise provision to make an agreement with Mr Johnson for a term of three years.

Fermoy.—The Town Commissioners have discussed with Mr. F. J. Warden-Stevens, A.M.I.C.E., of London, the practicability of lighting the town by electricity. Mr. Stevens said that he inspected the town and saw the water power available, and considered that Fermoy was admirably suited for electric lighting, and that the scheme would be profitable, giving increased light at less cost than that of gas. He advised the utilisation of water power, and thought that at least a thousand lights would be taken up by private consumers at present, the number of which would extend rapidly, and that one arc lamp of 1,500 c.p. would replace about four of the gas lamps and give a much better light. He advised the Board to apply to the Board of Trade for a provisional order. The Board decided to advertise for schemes and tenders from companies, and to submit them to Mr. Warden-Stevens.

Liverpool.—The Mersey Docks and Harbour Board give notice that the cable referred to in the notice to mariners, etc., of the 5th September last, by means of which electrical communication was to be established between the Formby lightship and the shore, has now been laid from the said lightship to a point near the Formby lifeboat house. The cable, after leaving the lightship, is laid towards Q 6 black can buoy, thence over Taylor's Bank and the Formby Channel to the southward of F 4 red conical buoy, to the point above mentioned. All masters, mates, pilots, fishermen, and others are cautioned not to anchor vessels or use trawls on or near the track of the cable. Mr. T L Miller, M.I.E.E., of Liverpool, has been asked to report to the Bootle Town Council on the electric lighting of the district, and to prepare estimates of the cost of plant and laying mains, with the necessary information as to working cost.

Devonport. — The Electric Lighting Sub-Committee have reported that they had had under consideration the notices received from the County of London and Brush Provincial Electric Lighting Committee and the Great Western Electric Light and Power Company of their intention to apply to the Board of Trade for provisional orders to supply electricity in the borough. Although the committee considered it would be expedient to defer any steps for the introduction of the electric light until more experience had been obtained, they were unanimously of the opinion that the control of such supply should be vested in the local authority, and therefore recommended the Council to authorise them to take such steps, if necessary, as they might advise for the promotion of an application to the Board of Trade for a provisional order during the ensuing session of Parliament. The report was adopted.

New Issue. — The London and Continental Investment Corporation, Limited, has been formed with a capital of £1,000,000, in 990,000 ordinary and 10,000 deferred shares of £1 each with the following objects: to acquire and hold any shares, stocks, bonds, debentures, or securities of any company, syndicate, or trust, and generally to act as finance and investment company; to prospect for, purchase, or acquire options over, develop, and work lands, concessions, mines, etc., and turn the same to account; to form and promote companies to take over such rights, and generally to act as an exploration and development company; and to construct and maintain railways, tramways, telegraph lines, gas, water, and electric works, etc. The first issue is of 500,000 ordinary and 10,000 deferred shares, and the whole of the issue of ordinary shares has been subscribed by and allotted to the signatories to the articles of association.

The Proposed Light Railway in Derbyshire.—The chairman of the provisional committee for the promotion of the light (electric) railway from Derby to Ashbourne has issued to the promoters a circular, in the course of which it is stated that "the scheme has been enthusiastically received by the Ashbourne farmers, and several gentlemen, thinking that it would benefit the agricultural community and promote local interests generally, have promised to subscribe towards the expenses of obtaining parliamentary powers, it being understood that in the event of the failure of the scheme any money beyond what is required for actual out-of-pocket expenses shall be returned to the subscribers ratably; but if the Bill is passed into law, and a company incorporated thereunder, £1 shares in such company shall be allotted to each subscriber for every £1 subscribed. Further support, however, is needed to justify the committee in proceeding with the application for the Bill."

Appointment Vacant.—The Ealing Urban District Council require an electrical engineer to superintend the whole of their electric lighting undertaking. His duties will be to take charge of the central electric station, transformer stations, and mains, and to superintend any future extension of mains. He must have had actual practical experience of alternating central-station work, and must devote the whole of his time to the duties of the appointment, and will be required to reside in Ealing within a reasonable distance of the central station. The system is high-tension alternating with transformer sub stations, and the street-lighting is high-tension continuous current. Applications, stating salary required (progressive), age, and previous experience, together with copies of not more than three testimonials of recent date, should be sent to Mr. William Ruston, clerk, Public Offices, Ealing, W., endorsed "Electrical Engineer," by 3 p.m. on November 6.

Birmingham.—As we intimated last week, it is proposed to try the overhead electric traction system upon the Nechells route should the necessary permission be given to the Central Tramways Company by the Birmingham City Council. The scheme, if sanctioned, will be carried out by Mr. Alfred Dickinson, engineer of the tramway company, who had charge of the introduction of the Walsall electric car system. To avoid the chief objection to the overhead system, it is suggested that the present lamp-posts upon one side of the road on the Nechells route shall be replaced by special posts, rising to about twice their height, and carrying the lamp at the middle of their elevation. The *Birmingham Post* says "Nechells is at present served by horse cars, but should the electric system be introduced and be found to give satisfaction, it would doubtless be proposed eventually for some or all of the other routes, upon which the ugly and otherwise offensive steam cars are at present tolerated only for the sake of the cheap means of locomotion they afford."

Stafford.—The Estates and Works Committee of the Town Council have recommended that an arc lamp be fixed in Market-square and that it—with the one in Gaol-square—be kept lighted at the expense of the electricity department to the end of the year, when, if the lighting prove satisfactory, the two lamps will be taken over by the Estates Committee at a cost of £22. 10s. per lamp, the requisities to be found by the department. The former recommendation was adopted; but the latter was referred to the Electricity Committee, it not being in accordance with the offer made by that committee. On the recommendation of the Gas and Electricity Committees, which in future will be amalgamated, the Council decided, in order to reduce the cost of raising steam for driving the machinery in the gas and electricity departments, to lay down a steam-main from the boiler-houses in the two departments at a cost of about £200, it being stated that this arrangement would enable the electricity department to do with two stokers. It was also decided to extend the electric lighting main as far as St. Paul's Church on Lichfield-road, at a cost of about £250.

Kingston-on-Thames.—The Lighting Committee have reported that the Native Guano Company had expressed their willingness

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to pay for the lighting of the sewage works by electric light, to the same amount as the average sum paid for gas in the last four years—viz., £71. 15s. 8d. per annum—and to agree to any reasonable and workable arrangement to prevent waste or undue consumption of current. It was left to the chairman the town clerk, and the engineer to make the final arrangements on these lines. The committee have instructed the town clerk to enquire whether the gas company would reduce the price for street lighting, and also to ask their terms for lighting the lamps by incandescent gas burners. The electrical engineer was instructed to report as to the cost of lighting the road opposite Surbiton Park-terrace with electric incandescent light. The accounts of the committee showed a debit balance of £102. 11s. 5d. The estimate for the lighting rate showed a prospective outlay for the ensuing six months of £3,160. 7s. 5d., of which £1,117. 16s. was for lighting gas lamps. The sum expected to be received from consumers of the electric light is £1,175, leaving £1,985 7s. 5d. to be raised by a lighting rate. The committee recommended a rate of 4d. in the £. The report was agreed to by the Council.

The New Berlin Tariff.—The Berliner Elektricitätswerke have published their new tariff, according to which after January 1, 1896, the electric light will be obtained in Berlin on more reasonable terms. The cost is to be calculated on the basis of the kilowatt-hour as a unit, by which means the tariff becomes a simple one. The starting price for a kilowatt-hour amounts to 60 pfennige (7¼d., very nearly), so that the price of a 16-c.p. incandescent lamp will be 3 pfennige (·36d.) per hour, while the cost of a 100-c.p. arc lamp, including the cost of the carbons, comes to 3·5 pfennige (·42d.) per hour. For those consumers who undertake to see after and renew their lamps themselves the tariff begins at once. In future it is only proposed to charge them for the current consumed and the rent of the meter. In addition to maintaining the present allowances, the following deductions will be given to all yearly consumers for lighting purposes on the basis of the current taken during the year, as follows:

Up to 10,000 marks	....	5	per cent.
,, 20,000 ,,	....	7½	,,
,, 30,000 ,,	.....	10	,,
,, 40,000 ,,	....	12½	,,
,, 50,000 ,,	. .....	15	,,
,, 75,000 ,,	.....	17½	,,
Over 75,000 ,,	....	20	,,

Separate installations belonging to the same owner, and serving similar purposes, will be counted as one and enjoy a corresponding reduction on their total consumption.

Wolverhampton.—The Coseley District Council have held a meeting to consider the question of public lighting. In the course of the discussion the engineer remarked that it was possible to light up straggling districts with electricity, and it had been accomplished in several places satisfactorily and economically. Councillor Rolinson said every member of the Council was pledged to provide light of some kind, the question for discussion being which illuminant would be the best. They could not erect gas-works of their own, neither could they purchase from the Bilston Gas Company their rights, and if they could, in some of the most dangerous portions of the district there were no mains The Chairman (Mr. Clayton) said the estimated expense of providing and fixing gas lamps was really only an outlay of a few hundred pounds to begin with, while an electric installation to be of any use, and to provide for private consumers, meant an outlay of £12,000, which they would probably regret. He thought they should not land the district into a big expenditure right away. A motion was subsequently carried in favour of gas lighting. Colonel Ducat, inspector of the Local Government Board, has held an enquiry at the Town Hall relative to an application of the Corporation for power to borrow £5,000 for extending the electric lighting station. Mr. Brevitt (town clerk) explained that the Town Council had obtained tenders for laying down additional plant and cables for supplying other public thoroughfares with electricity, and the cost was estimated at £5,000. The Corporation could not take any more customers nor provide further street-lighting without additional plant. There was no opposition.

Tunbridge Wells.—Councillor Ashby Wood, who was down on the agenda of the last Ratepayers' Association meeting to introduce "Electricity as a Motive Power," said he proposed to deal with electric tramways, which were to them the most interesting phase of the subject and a matter peculiarly suitable for any municipal body to take up. Having quoted statistics to show the relative use of electric traction in the United Kingdom and abroad, he explained that the index to success with all these tramways was a quick and constant service The total cost of electric trams was about 4d to 6d. per car per mile, which was about half what horse trams cost, while they travelled at an average speed of nine miles an hour. Having dealt with the three principal systems which might be adopted, the speaker said he should like to see electric trams in some parts of Tunbridge Wells, and suggested that one service might very advantageously be put down Upper Grosvenor-road to the baths and recreation ground. They were spending nearly £4 a week in keeping up those gardens, and he should like to see them brought more within the reach of all the inhabitants. A service to Southborough would also be a great benefit, and he considered if they could only get such a means of transit it would very much increase and maintain the popularity of the town. They had now a central station and machinery capable of working a day load, and there was no reason why they should not have the comfort and convenience of these cars and at the same time make a profit to the ratepayers. Alderman Clifford said they did not offer that convenience to their visitors to see the beauty of the place which other towns did. The subject then dropped.

Plumstead.—The Works Committee have recommended the Vestry to oppose the application of the Woolwich Electric Light Company to the Board of Trade for a provisional order enabling them to extend their mains into Plumstead. Mr. Adshead moved that the recommendation be referred back to the committee. Mr. Harbour, in seconding, said the committee ought to give reasons for their recommendation. If their objection to the company's application was based on the idea that the Vestry would supply the electric light to the parish themselves, then he agreed that that was a good reason, but it should be stated. The Chairman said that that was the reason. Mr. Harbour continued that if the Vestry were not going to supply the light it would be a dog-in-the-manger policy to prevent this company from doing so. Mr. Harper, chairman of the Works Committee, said the reason for the recommendation was, as stated, that it might be thought advisable for the Vestry to supply the light and there would be no room for two sources. Mr. Swift supported the opposition to the company's application, and said it would be a waste of time to refer the recommendation back. He anticipated that the Works Committee would before long take steps to have the electric light in the parish, the Vestry undertaking the work. Mr. C. Coton said that if the Vestry were to allow the company to enter Plumstead they might hereafter, when they decided to manage the electric lighting themselves, find that they had to saddle themselves with a system which was obsolete and useless, as constant changes and improvements were being made in the mode of lighting. The recommendation of the committee to oppose the company's application was agreed to.

Coventry.—In the course of a few weeks, a correspondent writes, the Coventry and district tramways, unused for three years past, will be once more in working order, only under a system infinitely superior to the original steam equipment, which at last had to be abandoned. The headquarters of the new system of the Coventry Electric Tramways Company, Limited, are at Little Heath—the old depôt. The main building at Foleshill, erected by Mr. C Haywood, jun., is 104ft long by 50ft. broad, and under that roof are included the car-shed, 60ft. by 50ft., engine-room, 42ft by 33ft., and boiler-house, 42ft. by 16½ft. In the generating department are two of Browett and Lindley's 120-h.p. engines and two Westinghouse dynamos. Here, too, is the switchboard, with voltmeter, three ampere-meters, four switches, and a couple of rheostats. Trial trips of the trams were to be made this week, and a fortnight later it is hoped to have the line in regular working order. The overhead system is used, and that fact gives reason to hope that these 5½ miles of tramway between Coventry railway station and Bedworth will be remunerative enough to ensure their permanency for locomotive purposes. It is intended to give a 10 minutes' service between the electric station and Coventry, and a 20 minutes' one from Foleshill to Bedworth. Mr. Graff Baker is the managing director of the company who own the property, and Mr. H. O'Neill the secretary. The equipment of the line has been made by the General Tramways Company, of London; Mr. A. E. Winslow has acted as chief engineer; Mr. Fletcher is resident engineer, assisted by Mr. Pritt; and Mr. McMahon road constructor. The charge of the sheds at Foleshill will be with Mr. Wimshurst. When the staff leave here they proceed to Douglas to lay an electric tram along the Head Marine Drive.

Electric Lighting in India.—A correspondent writes to an Indian contemporary: "I have read your article about electric lighting in the city of Calcutta and have been attracted by your remarks on aerial cables. Such cables as you suggest may be seen in Bombay, where electric installations are more numerous than in any other part of India, and where a number of very interesting specimens of cables, suitable for various systems of distribution, are on view. There one firm has laid underground cables which have given no trouble whatever for several years One of the samples examined by me had a diameter of about 2in., and consisted of central copper strands thickly insulated with some special medium, impervious to water and unaffected by the highest ground temperatures On this covering was wound the core for the return current—a layer of copper wires again insulated like the central core. Over the insulation were pressed two tubes of special soft lead alloy with a thin intermediate layer of bituminous substance to render the inner sheath impervious to any water leakage through the outer. The lead was covered by another specially watertight textile preparation, over which two steel tapes were wound in such fashion as to completely protect the cable beneath. One or more coats of impregnated textile stuff completed the cable—the object of these being to prevent moisture from reaching the steel armour." Messrs. Bousted Bros. have been requested by the Colombo Municipality to put up an arc light in Prince-street outside the M M. Office, and another at the lampstand in York-street at the junction of Prince-street and Main-street, and this work will be carried out as soon as their electric main has been laid, while it is expected that the entire lighting of the fort will immediately follow. Messrs Bousted Bros. are putting up the accumulators to better regulate the supply of electricity to the post office and the Queen's House. They expect to receive shortly the plant requisite for connecting the Bristol with the main, as part of it has already been shipped and the rest is to follow quickly.

Leeds.—The Tramways Committee of the Leeds Corporation have met to take steps with the object of carrying into effect the recent resolution of the City Council in regard to electric traction. In the course of a discussion, extending over two hours, various suggestions were made, and eventually it was decided to seek the advice of Dr. Hopkinson. Dr. Hopkinson is to visit Leeds and

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advise the committee as to the feasibility of working a service of cars by electricity, from the Canal Gardens in Roundhay Park *vid* North-street, Briggate, Boar-lane, Wellington-street, and Kirkstall-road, to Kirkstall. The idea of the committee is to extend the existing overhead wires from their present terminus opposite the Roundhay Post Office to the Canal Gardens, thus completing this section from the park to Sheepscar. The requisite wires are then to be carried longitudinally along a line of posts or standards down the centre of North-street, New Briggate, and Briggate, to the junction of the latter avenue with Boar-lane. From this point to the Queen's Hotel an experiment of the conduit system is to be made by laying the wires underground, and from the Queen's to Kirkstall they are to be suspended, as in Briggate, on a single row of posts along the centre of the road. No wires are to cross the thoroughfares anywhere between Sheepscar and the Kirkstall terminus, and all the streets and roads *en route* are to be illuminated by arc or other lamps attached to the posts or wires, as may be found most practicable. Details as to what the committee may wish to do with the existing plant of the Roundhay Park electric car system was not settled. Whether they may desire to take over any or all of the cars, wires, and generating machinery now in operation will depend to some extent upon the report of the authority mentioned. Dr. Hopkinson is to advise as to where he thinks power for the experiment might most advantageously be generated, and in making recommendations he is to have regard to the fact that the City Council have pronounced an opinion in favour of electricity on the overhead method.

British Electrical Manufacturing and Engineering Company.—We have received a copy of the prospectus of this Company, which has been formed, with a capital of £20,000 in 4,000 shares of £5 each, for the purpose of purchasing as going concerns, amalgamating, and carrying on (1) the goodwill, plant, machinery, stock-in-trade, etc., of the manufacturing department of the business of Messrs Laing, Wharton, and Down, electrical engineers and contractors, of New Bond-street, W.; (2) the goodwill, plant, machinery, stock-in-trade, etc., of the St. Martin's Electrical Manufacturing Company, Limited of Hammersmith, London, W. The Company will carry on the business of general electrical engineers in its various branches, but more particularly as manufacturers of all articles appertaining to electrical engineering, and will acquire from Messrs. Laing, Wharton, and Down a lease for the remainder of their term of that portion of their workshops in Haunch of Venison Yard, Piccadilly (rebuilt about four years ago and used for the manufacturing business), at the rent of £150 per annum, to include rates and taxes. Messrs. Laing, Wharton, and Down have, we understand, entered into a contract binding themselves not to engage in business as manufacturers of similar goods to those hitherto produced, nor will they manufacture for their own purposes, but will give the Company the orders for all such goods as they may require. The St Martin's Electrical Manufacturing Company, Limited, was incorporated with the primary objects of retaining and developing the connection of Mr. T. Duncan Dundas, the well-known electrical engineer, and from the commencement has been a signal success; many valuable contracts for the War Office, the Brush Company, Crompton and Co., and other well-known firms have been carried out, and at the present time it is stated that far more work and contracts are in hand than the limited capital allows it to properly cope with. The Company have secured the services of Mr. C. L Baker, M I E.E., as consulting engineer. Mr. Baker was the founder, and subsequently the managing director, of Chas L. Baker and Co, Limited, of Cornbrook Telegraph Works, Manchester.

Metropolitan Asylums Board.—The Local Government Board have sanctioned the placing of a contract with Callender's Bitumen Telegraph and Waterproof Company, Limited, to supply and lay electric light cables at the hospital ships, at an estimated cost of £125, without advertising for sealed tenders. The Brook Hospital Committee brought up the following report, which was at once agreed to: "We beg to report that in accordance with the authority given us on May 11, 1895, Prof. A. B. W. Kennedy, LL D., F.R.S., has been instructed to prepare plans and specification for the installation of the electric lighting of the Brook Hospital, and we now submit for the managers' consideration the plans and specification which he has prepared. Prof. Kennedy advises that tenders for the engines, dynamos switchboards, and batteries should be obtained from a selected list of firms, but that the remainder of the work, such as wiring, etc., may be put to public tender. We concur in the opinion expressed by Prof. Kennedy, and we submit the following list of names of firms, as advised by him, from whom we recommend tenders should be obtained—viz.: Messrs. Siemens Bros. Woolwich; Messrs. Crompton and Co., Chelmsford; Messrs. Johnson and Phillips, Charlton; Messrs. J. H. Holmes and Co., Newcastle-on-Tyne; Messrs. Thos. Parker, Limited, Wolverhampton; Messrs British Thomson-Houston, Limited, Westminster; Messrs. W. H Allen, Son, and Co., Bedford; Messrs. Mather and Platt, Salford; Messrs. Davey, Paxman, and Co., Colchester; Messrs. Robey and Co., Limited, Lincoln; Messrs. Marshall and Sons, Limited, Gainsborough; the Electric Construction Company, Wolverhampton. We recommend (*a*) that tenders be invited from the list of firms referred to in the report of the Brook Hospital Committee for the dynamos, batteries, switchboards, and engines for the electric light installation of that hospital; (*b*) that the Brook Hospital Committee be empowered to issue advertisements inviting tenders for the remainder of the work (wiring, etc.) connected with the installation of the electric light of that hospital and the adjoining ambulance station." The Ambulance Committee reported as follows: "In accordance with the intimation given in our report of July 20 last, we now submit a specification, prepared by Prof. Kennedy, for the wiring of the Brook Ambulance Station, and for the supply and fixing of all fittings, etc, necessary for lighting it by electricity. The cost of the work is approximately estimated by Prof. Kennedy at £300. In our opinion it will be of advantage if this work could be carried out by the contractor who will be employed to execute similar work in the adjoining Brook Hospital. We therefore recommend (*a*) that the specification for wiring, etc., the Brook Ambulance Station be included, but at a separate price, in the contract for the execution of similar work at the Brook Hospital; (*b*) that for preparing the specification, and supervising the execution of the work, Prof. Kennedy be paid a commission of 5 per cent. on the cost thereof." This was agreed to.

Proposed Electric Tramway between Fleetwood and Blackpool.—This scheme has been approved. The Fleetwood Urban Council held a special meeting on Monday to receive and consider correspondence in connection with the proposed application for powers to construct tramways in the district. The promoting company propose to construct a double line of tramways on the overhead electrical system from Blackpool to Fleetwood, commencing at Talbot-road Station, running thence along Dickson and Warbrick roads to the Gynn, thence along the cliffs to Norbreck and Little Bispham, leaving the cliffs at Anchorsholme, thence following the highway to Rossall, thence across the fields to Flakefleet to a straight line, being a continuation of the Copse-road, following the north-west side of that road to West-street, up North Albert street to North Euston Barracks. Owing to the recent attitude taken up against the Blackpool Corporation by certain of the ratepayers in reference to the purchase of the Gynn Estate, it is very probable that the tramways in the borough will be postponed to another season, but at the same time, provided the promoters can get a satisfactory agreement with the Blackpool Corporation, they will in the first instance make the tramway from the borough boundary to Norbreck This can be done without either Act of Parliament or provisional order. If, however, satisfactory arrangements and assistance can be got from the Fleetwood people, the Local Board, and the large landowners on the route, the promoters will go for a Bill this session and make the tramway from Blackpool to Fleetwood; if not, the tramway will stop at Norbreck. The company asked for the assistance of the Council, authorising by resolution the making of the tramways in their district, and for the erection of an electrical station for creating power to drive the tramway cars. The following resolution was unanimously carried: "That the proposed applications for powers to construct and work tramways within this district, as per letter now read from Mr. B. Sykes C.E., be approved, subject to the plans and working details being approved when ready, and also subject to the draft provisional order or Bill being satisfactory in all respects to this Council."

Willesden.—Mr. O Claude Robson, engineer and surveyor to the Willesden District Council, has issued the twentieth annual report of the Council for the year ended March 31, 1895. In it he says: "A suggestion has been made by the Hampstead authorities to supply electric lighting to the High-road, subject to a moiety of the cost being defrayed by the Willesden District Council. The amount of such moiety, however, was so excessive that the offer could not be entertained. Independently, however, of the cost involved, it is a point for consideration whether it would be possible for Hampstead to supply outside their boundaries without obtaining special powers for same. It is also doubtful if it would be a wise policy for Willesden to forego any possible benefit that might hereafter be derived from electric lighting to premises in the High-road, should the District Council themselves obtain a provisional order in the future for electric light within their district. When the time does arrive for adoption of electric lighting, it is strongly advisable that all supply should be controlled by the Council rather than be in the hands of a neighbouring authority or private company. Should the suggestion, therefore, of the Hampstead authorities be entertained, I would recommend that it be subject to a terminable agreement, and that any future powers that may be obtained by the District Council should be safeguarded, Telephonic communication is provided at the Kilburn fire station Salusbury-road, to the following localities—viz., Public Offices; fire-escape, Storeyard; police station, Kilburn; turncock, Kilburn; isolation hospital, Neasden; sewage works, Neasden; fire station, Harlesden; medical officer, Harlesden; police station, Harlesden; turncock, Harlesden. The whole of the above communication is the property of the Council the work having been carried out by the late Local Board. The former contract with the General Post Office for an annual rental for telephonic service between the police station and the Harlesden fire brigade station has been cancelled. The price formerly paid to the General Post Office for the service before mentioned was £26. 15s per annum, whilst the sinking fund of the loan for the entire work recently carried out by the Local Board, together with maintenance, will represent but £64. 6s 9d. per annum, notwithstanding this work provides treble the communicating length that was included in the contract with the General Post Office, and also includes all wires and apparatus connected with the communication to hospital, sewage farm, offices, etc. The wires are partly conveyed by iron poles along highways, and partly by attachments to houses, but I am glad to report that I was able to obtain easements in every case without any pecuniary compensation or yearly rental. The total length is about 3¾ miles, and the entire cost has amounted to £111. 6s. 11d. The work was carried out by Mr. F. E. Stuart, of Ealing, who maintains the whole of the wires and appliances for the sum of £25 per annum. A portion only of both capital

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and annual cost is allocated to fire brigade expenditure, as a large amount of the work was connected with the isolation hospital. Two additional alarm posts have been fixed, making a total of 10 now provided throughout the district. The whole of the foregoing posts are supplied and fixed by the General Post Office, who charge a rental of £137. 10s. for the entire system, which represents an average sum of £13 15s per post. With regard to the post at Willesden Green, adjacent to the sub-station at Poplars-avenue, it is most desirable that this should be connected by telephone with the central station in Salusbury-road in a similar manner tc the new sub-station in Dyne-road. The whole of the call-bells and wires formerly con necting the volunteers' residences with the old station in Bridge-street, Kilburn, were removed and utilised as far as possible in the provision of elec'rical calls to the men's quarters at the new station. The system of electrical call still, however, exists at Harlesden, where the houses of the volunteers are connected with the fire brigade station in High-street."

Cork.—Mr. T. W. Smith, of Messrs. Calvert and Co., of Manchester, has submitted to the Town Council of Cork his report on the proposed electric lighting of the city. He advocates the adoption of the low-tension system. For comparison, he has drawn out two distinct schemes—one for public lighting, the other for the necessary plant and mains for lighting the shops, offices, warehouses, etc. Public lighting.—For efficient lighting of the streets he has suggested about 100 arc lamps, each of a nominal 2,000 c.p., fixed on cast-iron pillars about 50 yards apart, arranging them in the centre of the wide streets, and alternating them on either side of the narrow streets. He estimates the cost of this scheme, including duplicate plant in case of breakdown, at approximately £8,000, which is made up as follows: cable and laying, £2,100; 100 arc lamps erected, £2,500; buildings, say, £250; 200 h.p. engines, £920; two boilers, £850; two dynamos, £800; switchboard and instruments, £150—total, £7,570, or, in round figures, £8,000. The annual cost of maintenance of this station would be approximately £2,000, made up as follows: coal, calculated at 2½lb. per horse-power per hour, engines working all night, at 15s. per ton, £200; 3½ per cent. interest on £8,000, £280; 5 per cent. depreciation, £400; carbons, £200; two enginemen, £200; two firemen, £100; two trimmers, £80; resident engineer, £200; oil and sundries, £70—total, £1,730, or in round numbers, £2,000. Alternative scheme.—In drawing out an alternative scheme for incandescent lighting—that is, for plant and mains to supply consumers—he has included heavy mains to certain points of the city, from which any after extensions can be taken at very little cost. He has also included mains large enough to admit of the public lights being taken off the same wires as the consumers', and has quoted a price for a system suitable for electric lighting. He estimates the cost of this scheme, which includes plant for 100 arc lamps, plant and mains for 5,000 8-c.p. incandescent lamps, and mains for an extension of 10,000 more 8-c.p. lamps, or the equivalent of same, to be approximately £20,000, made up as follows: cable and laying, £7,000; one 200-h p. and two 100-h.p. engines, £1,500; three 150-h.p. boilers, £1,725; three dynamos, £1,300; buildings, £250; fixing engines, £500; mason's work, £500; meters and house connections, £1,000; switchboard, etc., £500; arc lamps and fixing, £2,500—total, £16 775; or, in round figures, £20,000. The cost of running this plant per annum he estimates to be £3,000 made up as follows: 350 h p (or the power required for 5,000 8-c.p. lamps and all the public lighting) to run from dusk to 9 p.m., or approximately 1,000 hours per annum: coal account, £220; 100 h.p., or the power required to run the public lights only from 9 p.m. to daylight cost account, £100; 3 per cent. interest on £20,000, £600; 5 per cent. depreciation, £1,000; labour, two men at £100 per annum, £200; six men at £50 per annum, £300; engineer, £300; repairs and sundries, £200—£2,920, or, in round figures, £3,000. With reference to the public lighting, this estimate is a liberal one, as, no doubt, arrangements could be made to put out a certain number of lamps, say, at 12 p.m., and thereby reduce the cost of upkeep. In estimating the prospective revenue, he is assuming that the 5 000 8-c.p. lamps, or their equivalent in 16-c.p. or arc lamps, would be taken up by the various residents on the mains, and that one unit of current will supply 40 lamps for one hour. We have, therefore, 125,000 units per annum sold, which, at the small sum of 6d. per unit, would bring in a revenue of £3,125 per annum. This being exclusive of the public lamps we have maintained free, and a profit of. say, £125 in cash. Again, this profit is exclusive of any revenue which might be derived from the sale of current in the daytime for traction work, etc. In conclusion, he has prepared a rough plan showing the area proposed in this scheme, and would suggest that before lightly selling the provisional order to any private company a deputation be sent to enquire more fully from stations working on the proposed system what their views are. The committee report on this: "Without committing themselves to the various details of either scheme, your committee are, however, of opinion that sufficient has been shown by the report under consideration to warrant them in recommending, and they do accordingly recommend, the Council to authorise the town clerk to take all necessary steps to obtain for the Corporation a provisional order enabling them to borrow money, erect works, provide and work all necessary plant, machinery, etc, for the production, storing, distribution, and sale of electrical energy, for all public and private purposes, within the compulsory area defined by Mr. Smith's report, or such modification or extension thereof as the Corporation may meanwhile determine; and also, at the option of the Corporation, within such larger area, not exceeding three miles from the borough boundary, as the Council may in like manner determine and the provisional order define. When the Corporation shall have obtained the provisional order above referred to, it will then be open to them to consider whether they should themselves exercise the powers thereby to be conferred, or contract with some company duly authorised, to carry out the work of electrical supply for public or private purposes, or for both, as may be determined, and on such terms, conditions, and powers of resumption as may be agreed upon between the Corporation and such company. As a corollary to the foregoing recommendation, your committee further recommend that the Corporation dissent from the applications proposed to be made for provisional orders by the Cork Gas Consumers' Company, the Cork Electric Light and Power Company, Limited, and Mr. Edward Felton on behalf of a company to be formed, respectively, and of which notice has been severally given to the Corporation." The Council have adopted the report.

Cardiff—Mr. W. J. B. Clerke, M.I.C.E, the inspector appointed for the purpose, has held an enquiry into the application of the County Council of the borough of Cardiff to the Local Government Board for sanction to borrow £12,885 for purposes of electric lighting, £1,576 for the improvement of Roath Park, £500 for the purpose of public lighting, and £200 for laying out Windsor Esplanade Gardens. The Mayor (Alderman P. W. Carey) and the Borough Engineer (Mr. W. Harpur) gave evidence in regard to the item of £12,885, his Worship stating that the compulsory area was now lit; £5 385 of this sum was for extensions in Newport-road, Castle-road, West grove, Charles-street, Bute street, Guildford-crescent, Park-place, Corbett-road, Royal and High-street arcades, and Trinity-street, as well as the erection of a testing-room. The remaining £6.500 was for defraying the excess of expenditure over capital already borrowed and for other purposes. Mr. S. Walker, electrical engineer, criticised in certain particulars the Cardiff electric lighting scheme, and alleged that the expenditure was greatly in excess of what it should have been. Mr. Harpur was confident the scheme would pay. Mr. Massey, Corporation electrical engineer, said the applications were increasing at a phenomenal rate. Mr. Harpur: For the last two months they have equalled nearly 1,000 lamps per month. Mr. Walker: What is the capacity of the maximum load? Mr. Harpur: Between 8,000 and 10,000. Mr. Walker knew as a fact that mains had been laid a second time, in one case starting a leak big enough to light an eight-candle lamp. Mr. Massey: That is not so. Mr. Harpur: It is absolutely false. Mr. Walker: I tested it myself. Mr. Walker next asked if any portion of the money was for the lighting of the market and Town Hall. The Inspector: It is not mentioned in the figures before me. Mr. Harpur said he had given all reasonable information to Mr. Walker, who was absolutely wrong in the statements he had made. Mr. Walker: What are the facts of the Town Hall and market hall lighting? The Inspector: That cannot be entered into at this enquiry. We cannot go into irrelevant matters. Mr. Harpur said that Mr. Walker's tender for the work was double £500; so that if it cost £600 or £700, surely it was a cheap job. Mr. Walker insisted that it was a public matter, and said he didn't want the contract if that was any information to Mr. Harpur. Mr. Harpur: You were anxious to tender, at any rate. Mr. Walker: No, I was not. I tendered as I tender for everything else. Mr. Harpur informed Mr. Walker that in reference to the Town Hall and the market they had two contracts—one for the wiring and the other for supplying the fittings. Mr. Walker wanted to put those accounts together. Mr. Walker then said if Mr. Harpur had given him information there would have been less trouble in the public Press The Town Clerk (Mr. J. L. Wheatley) remarked that if Mr. Walker had applied to Mr. Harpur he would have been furnished with all particulars, and saved himself a lot of trouble. Mr. Walker next asked if he could not get into the electric lighting station. The Town Clerk: Make the application, and you will have an official answer. Mr. Harpur: I have not refused admission to Mr. Walker or any other person. Mr. Walker: I have been refused. The Town Clerk: There is always a right way and a wrong way. Make a written application, and it will be received with every courtesy. Will that satisfy you? Mr. Walker: It will satisfy me now. The Lighting and Electrical Committee recommended on Monday that the rectifiers be removed from the Town Hall to the central station at Canton, at an estimated cost of £700 or £750, as such removal will effect a saving in wages of about £175 per annum. Councillor Riches pointed out that the recommendation was on all fours with his own contention at the very outset of the project. It was reported that the borough engineer considered that the installation of the electric light was now completed so far as the compulsory area was concerned. The Mayor explained that the placing of the rectifiers in the Town Hall meant a saving at the time of the cost of laying the necessary mains between Canton and the Town Hall, so that their removal really meant no additional cost. Having the rectifiers at the central station would enable three men having charge of them to do work in other departments also. Applications for installations were coming in in a very satisfactory manner, and he hoped that 12 months hence the electric light at Cardiff would prove not only a public boon but a paying concern. The borough engineer was instructed to start a day load forthwith. Mr. Massey, the late consulting engineer, has offered to be a member of the deputation to confer with the Local Government Board on the subject of electric lighting, at no expense to the ratepayers. The Electrical Committee, however, decided that Mr. Appleby, the chief electrical engineer at Canton, was the proper person to accompany the mayor, the town clerk, and the borough engineer. A deputation from the Machinery and Lighting Committee of the Cardiff Exhibition asked the committee to assist them in the lighting of the exhibition. It was stated that the probable number of lamps required

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would be about 1,200 incandescent, of 15 c.p., and 200 arc lights. After conference with the engineers it was announced that this amount of lighting was equal to half the amount now created at Canton, and that to supply the lamps required the town would be put to an expenditure of at least £10,000. Eventually it was agreed that the Mayor, Alderman Jacobs, and Councillor Evans be selected to meet a sub-committee of the Exhibition Lighting Committee, an understanding being arrived at that, it being impracticable for the town to supply the energy, the exhibition promoters should lay down an installation plant of most recent type, to be approved by the borough and electrical engineer, so that it could be utilised by the town afterwards.

PROVISIONAL PATENTS, 1895.

OCTOBER 21.

19734. **Improved means or apparatus for electrically igniting petroleum and other like motors.** Count Albert de Dion and Charles Bouton, 78, Fleet street, London.

19745. **Improvements in and in the manufacture of plates for electric accumulators or secondary batteries.** Johannes Körner, 6, Lord-street, Liverpool.

OCTOBER 22.

19815. **An electromagnetic apparatus for actuating railway brakes and switches** Charles Melbourne White, 27, Southampton-buildings, Chancery-lane, London. (The St. Louis Brake Company, United States). (Complete specification.)

19828. **Improvements in electrolytical apparatus.** Richard Heathfield and William Stepney Rawson, 28, Southampton-buildings, Chancery-lane, London.

19832. **Improvements in connection with electric propulsion.** Anthony George New and Arthur James Mayne, 55, Chancery-lane, London.

19833. **Improvements in connection with the electrical propulsion of vehicles.** Anthony George New and Arthur James Mayne, 55, Chancery-lane, London.

19837. **Improvements in electric arc lamps.** Thomas Edgar Adams, 18, Buckingham-street, Strand, London. (Complete specification)

19838. **Improvements in electric arc lamps.** Thomas Edgar Adams, 18, Buckingham-street, Strand, London. (Complete specification)

19839. **Improvements in dynamo generators or motors.** Albert de Puydt and Maximilien Poncin, 60, Queen Victoria street, London. (Complete specification.)

19860. **Improvements in regulating electric motors.** James Devonshire, 70, Chancery-lane, London (William B. Potter, United States) (Complete specification)

19861. **Improvements in three-wire electric railways.** James Devonshire 70, Chancery-lane, London. (William B. Potter, United States). (Complete specification.)

19862. **Improvements in dynamo-electric machines.** James Devonshire, 70, Chancery-lane, London. (Elihu Thomson, United States). (Complete specification)

19863. **Improvements in regulators for alternating currents.** James Devonshire, 70, Chancery-lane, London. (Charles P. Steinmetz, United States). (Complete specification.)

OCTOBER 23.

19925. **An automatic cut-off for atmospheric gas-burners and electrical heating stoves.** Charles Goodwin Norton, 38, Marchmont-street, Russell-square, London.

19947. **Improvements in electric contact devices.** Carl Moradelli, 323, High Holborn, London. (Complete specification.)

19973. **Improvements in or connected with electric lamps.** William James Davy, 40, Chancery-lane, London.

OCTOBER 24.

19989. **An electrical "tell tale" or watchman's recorder.** John William Fletcher, The Homestead, Cale Green, Stockport.

19992. **Improvements in the method of laying an electric cable for tramways or railways and in the means of communication between the conductor and the car.** Crawford Barlow, 154, St. Vincent-street, Glasgow.

20028. **Improvements in the brushes of dynamos.** Frederick John Chaplin and Robert Chaplin, 77, Colmore-row, Birmingham.

20047. **An improvement in the caps of incandescent electric lamps.** The Edison and Swan United Electric Light Company, Limited, and Arthur Woodley, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

20048. **Improvements in or pertaining to electrically-driven pumping apparatus.** Francis Edward Elmore, the Old Hall, Knostrop, Leeds.

20071. **Improvements relating to electric railways.** Alfred Philippi, 18, Southampton-buildings, Chancery-lane, London.

20073. **Improved means to be employed in the production of sheets or strips or equivalent forms of metal by electro-deposition.** Sherrard Osborne Cowper-Coles, 47, Lincoln's-inn-fields, London.

OCTOBER 25.

20131. **An improved manufacture of secondary or storage battery plates.** Paul Opitz and Wilhelm Petschel, 45, Southampton-buildings, Chancery-lane, London.

20132. **Improvements in generating gases or steam by electricity from water, oil, or other suitable material.** John Henrique Dunn and John Parsons, Saville House, Wood Green, London.

20164. **Improvements in or connected with the production of metal in sheets or other form direct from zinc ores, applicable in part for use in the electrolytical deposit of metals generally.** Sherrard Osborne Cowper-Coles, Maurice Ulcoq, Walter Murray Guthrie, and Carrington Riddell Gordon Smythe, 47, Lincoln's-inn-fields, London.

OCTOBER 26.

20214. **Improvements in tubular galvanic batteries.** Edward Stanley Boynton, Prince's-chambers, Wolverhampton. (Complete specification.)

20215. **Improvements in double-fluid galvanic batteries.** Edward Stanley Boynton, Prince's chambers, Wolverhampton. (Complete specification.)

20216. **Improvements in galvanic batteries.** Edward Stanley Boynton Prince's chambers, Wolverhampton. (Complete specification)

20237. **An improvement in electric safety fuses.** The Edison and Swan United Electric Light Company, Limited, and Charles Faraday Proctor, 28, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1894.

19681. **Coin-freed telephonic apparatus.** Miller.
21367. **Electrically-propelled vehicles.** King.
22531. **Electric circuits.** Smith.
23505. **Electric light fittings.** McFarlane.

1895.

497. **Electric batteries.** Love. (Second edition.)
6163. **Secondary voltaic battery.** Buckland. (Second edition.)
12498. **Electrical insulating compound.** Meirowsky.
16439. **Dynamo-electric machines.** Royce.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6½
Brush Company, Ordinary	3	1⅛-1¾
—— Non. Cum , 6 per cent. Pref.	2	2-2⅛
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5⅛-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6¾-7¼
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	13-14
—— 6 per cent. Cumulative Pref.	10	15-16
—— 5 per cent. Debenture Stock	100	133-137
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	132-134xd
—— 5 per cent. Pref. Shares	10	14⅜-15¼
County of London and Brush Provincial Co., Ordinary	10	8¼-9⅛
—— 6 per cent. Cum. Pref.	6	8⅜-9⅛
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅝-2⅛
Edison and Swan United Ordinary	3	1⅝-2⅛
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	¾-1
—— 6 per cent. Debentures	—	98-102
—— 7 per cent. Cumulative Pref.	2	2-2⅛
Elmore's Copper Depositing	2	⅜-½
Elmore's Wire Company	2	1-1⅛
Fowler-Waring Cables	5	⅞-1
W. T. Henley's Telegraph Works, Ordinary	10	14⅛-14½
—— 7 per cent. Preference	10	15⅛-16⅛
—— 4½ per cent. Debentures	100	107-110
House-to-House Company, Ordinary	5	4⅛-4⅜
—— 7 per cent. Preference	5	8-8⅛
India Rubber and Gutta Percha Works	10	19-20
—— 4½ per cent. Debentures	100	100-102
Kensington and Knightsbridge Ordinary	5	8-8⅛
—— 6 per cent. Pref.	5	7-7⅛
Liverpool Electric Supply, Ordinary	5	7⅞-8⅛
Liverpool Overhead Railway	10	11 15/16-12 1/16
—— 5 per cent. Pref.	10	15-15½
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric Supply	5	⅜-⅝
Metropolitan Electric Supply	10	11-11½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-120
National Telephone, Ordinary	5	6-6½
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15½-16½
—— 5 per cent. Non. Cum. Third Pref.	5	6½-6¾
—— 3½ per cent. Deb. Stock	100	106-108
Notting Hill Company	10	8¼-9¼
Oriental and Electric Company, £1 shares	1	1-1½
—— £5 Shares	5	7½-7⅞
—— £4½ shares	4½	6¼-6½
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-105
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8½-8¾
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	43-45
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4⅛-4⅜
Westminster Electric Supply, Ordinary	5	8⅛-8¾
Yorkshire House-to-House	5	6¼-7

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NOTES.

African Natives and Telegraphy.—A correspondent says that the telegraph in Central Africa will in time be worked entirely by natives, who are wonderfully quick at learning the system. Their keen eyesight makes them especially proficient in heliographic work.

Light Railways.—Mr. Ritchie, the President of the Board of Trade, accompanied by the Earl of Dudley and Sir C. Boyle, the parliamentary and permanent secretaries of that Department, left London last Friday on a short visit to Belgium and France, for the purpose of seeing certain of the light railways in operation in those countries. Mr. Ritchie intended to return to town to-morrow.

Cheap Telegraphy.—It may be remembered that cheaper telegraphy to Australia was introduced by the Governments of Colonies guaranteeing the cable companies against a portion of the loss. In last year, ending with April, the heavy traffic through gold-mining led to the receipts rising above the guaranteed sum. Hence, the Colonies get cheaper telegraphy without cost after three years of small contributions.

Royalty Patronises Electricity in Austria.—Considerable prominence is given in the new number (November 1) of the *Zeitschrift für Elektrotechnik* to the fact that "His Imperial and Royal Highness the Most Serene Herr Archduke Carl Ludwig has been graciously pleased to undertake the patronage of the Elektrotechnischer Verein in Vienna." The Archduke makes the announcement in a letter in which he dwells upon the importance and the great development of electrical engineering.

Glucinum.—The metal glucinum, hitherto a chemical rarity, is likely to come forward as a useful material, especially in electrical work. It is only twice as heavy as water, and is therefore even lighter than aluminium. It is a good deal less extensible than iron, and it has an electric conductivity nearly equal to that of silver, greater than that of copper. It is more durable than iron. At its present price, 71s. 4d. per pound, it is one-tenth the price of platinum, weight for weight, and 1-160th the price, volume for volume.

Institution of Electrical Engineers.—The Institution of Civil Engineers have kindly consented to permit the meetings of the Institution of Electrical Engineers to be held in the new building of the former institution, but as there is some doubt as to whether the building will be sufficiently advanced to allow of the use of its lecture hall on the 14th inst., the Council of the Institution of Electrical Engineers have decided to postpone the opening of their session until the 28th inst. The annual dinner of the Institution will take at the Freemasons' Tavern on Friday, the 29th inst.

Electric Traction for Army Purposes.—M. H. Maigne has called attention to the facilities which would be afforded for mobilisation and the transport of army supplies if some system of electric traction were provided on the canals leading to the frontiers. *L'Eclairage Electrique* of October 26, after remarking on the superiority of water transit for the removal of the wounded, says that the canals leading to the eastern frontier of France would be able to take the heavy transport of five army corps, and considers the question worthy of the attention of the military authorities.

Heriot-Watt College, Edinburgh.—The professorship of applied physics and electrical engineering having become vacant by the appointment of Prof. Mullineux Walmsley to be principal of the Northampton Institute, Clerkenwell, London, the Governors of the Heriot-Watt College announce that they will be glad to receive applications from candidates for the appointment. The new professor will commence duty on January 1, 1896. Applications, accompanied by 30 copies of testimonials, should be sent to Mr. David Lewis, treasurer, 20, York-place, Edinburgh, before 22nd inst. The salary attached to the professorship is £400 per annum.

Flywheel Accidents.—Just a few hours before the recent fatal flywheel accident at Hoboken a 15ft. wheel burst at the station of the Homestead (Penn.) Electric Light and Power Company, instantly killing the engineer. The plant was damaged to the extent of 2,500dol. Pieces of the wheel tore through the sheet-iron roof and demolished the floor, and one fragment went through a 3ft. brick wall. A large piece was thrown high in the air and fell into a neighbouring newspaper office, causing a loss of 500dol. The plant had not been operated for three weeks before the accident occurred, and it will take two weeks to repair the damage, during which time the station will be shut down.

"Holding Up" a Trolley Car.—Five armed and masked men "held up" a trolley car of the North Shore Electric Street Railway Company near Berwin-avenue, between Chicago and the suburb of Evanston, one night recently, cut the wire, thus preventing assistance from following cars, and putting out the lights, and then robbed the 18 passengers of their money and valuables. A passenger named T. P. Nesbitt, of Evanston, drew his revolver, but it was knocked from his hand by one of the robbers and discharged, the bullet striking Nesbitt in the leg. The conductor saved his money by dropping it down between the walls of the car and the window openings. The robbers, of course, escaped.

Electricity and Tadpoles.—Some curious experiments on tadpoles are described in a lecture by Dr. A. D. Waller, published in the current issue of *Science Progress*. A cell fitted with suitable electrodes and filled with water in which one or more tadpoles were placed, was traversed by an electric current. If the direction of the current was such as to pass from head to tail, the tadpole waggled his tail; but if passed in the other direction he lay quiescent. A large trough in which a number of tadpoles were swimming about in all directions was also traversed by the current, which excited great commotion among its occupants for a few moments, but finally the whole of them came to rest with heads and tails lying in line with the direction of the current.

The Spectra of Carbon Electrodes.—Mr. W. Noel Hartley contributes a reply to Herren Eder and Valenta's criticisms on a previous paper by Messrs. Hartley and Adeney. The author still thinks that the lines with the wave-lengths 3881·9, 3870·7, 3589·9, 3584·8 are carbon lines, and not the edges of cyanogen bands, as Herren Eder and Valenta state. These same lines are obtained from the combustion of cyanogen and from carbon electrodes surrounded by saline solutions, but are not given by cyanides. A list is given of the lines which appear under different circumstances when condensed sparks are passed between graphite electrodes. This list includes the lines of dry electrodes in air, in carbonic anhydride, and in oxygen.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on the 4th inst., Sir James Crichton-Browne presiding. The following were elected members: H.R.H. Prince Louis Philippe, Duc d'Orleans, Sir John Evans, K.C.B., F.R.S., the Hon. Adrian Verney Verney-Cave, Mr. Walter Allcroft, and Mr. James Beale. The managers reported that the late Mr. John Bell Sedgwick, M.R.I., had bequeathed £300 to the Royal Institution in aid of the fund for the

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promotion of experimental research at low temperatures. The special thanks of the members were returned to Sir Frederick Abel, Bart., for his donation of £50 to the fund for the promotion of experimental research at low temperatures.

A House Railway.—There are rumours that the well-known entertainer, Mr. George Grossmith, intends to convert his house railway, popularly known as the Dorset-square Railway, into an electrical line, he having been smitten with the charms and possibilities of the subtle current. The railway, it seems, runs through his residence from the main terminus, the reception-room, through the hall to the stables, the other terminus being the coach-house. The present steam-engine is 3ft. high, and is capable of attaining a comparatively high rate of speed. The whole plant complete originally cost about £500. It is stated that one of the most humorous sights imaginable is to watch Mr. Grossmith as, seated in the tender in company with one or two juvenile friends, he starts the train, peering anxiously in front in order to avoid any possible accident, turning on and shutting off steam as occasion requires, and invariably arriving at the journey's end with passengers and train intact.

"Autocars."—The new journal, the *Autocar*, referring to the Chicago *Times Herald* having offered a prize of 5,000dol. for the most satisfactory vehicle in a performance over the 100 miles of road between Milwaukee and Chicago, says it will show to what an extent the movement is laying hold of the American public when they say that over 60 different firms have entered vehicles. One of the first entrants is a machine to carry a complete load of 4,250lb., and to do 50 miles by electricity without recharging. The accumulators weigh 1,600lb., and the carriage can do 16 miles an hour. Amongst the others will be an aluminium-bronze engine of 6 h.p., weighing with the carriage only 140lb. It is probable, therefore, the journal adds, that some very remarkable results may be the outcome of this race, although in point of mere speed possibilities the vehicles will be at a disadvantage compared with their Continental competitors, as the course is a rough and trying one, and not to be compared with "the sand-papered roads of France."

Safety Fuse Competition.—The Verband deutscher Elektrotechniker offers a little prize of 300 marks (£15) for the best form of unchangeable fusible cut-out, with the view of obviating the insertion of fuses for higher current strengths than may be determined upon. As standard figures for this purpose are given—for the current, 50, 100, 400, and 1,000 amperes, with average distance between the fuse screws 70, 80, 95, and 110 millimetres, and as diameter of the screws $\frac{1}{4}$in., $\frac{5}{16}$in., $\frac{1}{2}$in., and $\frac{3}{4}$in. respectively. The judges in the competition are to be the Committee for the Introduction of Uniform Contact Sizes and Screws, whose recommendations were accepted by the recent Munich meeting of the Verband. Competitions, furnished with a motto, and accompanied by a sealed envelope containing the name of the sender, are to be forwarded up to April 1, 1896, to the Geschäftsstelle des Verbandes deutscher Elektrotechniker, Berlin, Monbijouplatz 3. The announcement of the winner of the premium will be made at next year's meeting of the Verband in Berlin.

Tractive Power of an Electric Locomotive.—On October 6 electric locomotive No. 1 (which has often been referred to in our columns), used in hauling freight trains through the Belt Line tunnel of the Baltimore and Ohio Railroad, demonstrated that its drawing power far exceeded the expectations of its builders. Forty-four loaded freight cars, and three steam locomotives, not working, which had been used to haul the heavy train on the surface, were coupled to the electric giant at the tunnel entrance and pulled up the heavy grade of the tunnel, a speed of 12 miles an hour being developed. The total weight of the train was 1,900 tons. The drawbar pull exercised in starting this unusually heavy load was more than 60,000lb., and continued throughout the trip at more than 40,000lb. Baltimore and Ohio officials claim that no steam locomotive ever approached this record. No. 1 has been in regular service day and night since August, hauling freight trains through the tunnel, and has not missed a trip. Two smaller locomotives are building at the General Electric Works at Schenectady, N.Y., and upon their arrival in a few weeks the passenger service will be taken up and the tunnel operated entirely by electricity.

Electricity in Plant Growth.—Lieutenant Stuart-Smith suggests a reason for the great variation in the plant growth when there is but little apparent difference in the climatic conditions; he also offers a possible explanation of the action of light in producing chemical decomposition. In connection with the first part he states that bare wires placed in the ground, so that the current passing between them tends to pass through the roots of the plants, will greatly enlarge the roots of certain vegetables and the tops of others; and he suggests that earth currents, such as are known to exist, might have such an effect on the crops. A carefully-kept record may possibly show that over a large area during some years these earth currents may be much above the normal, while during other seasons they may be much below, and an examination of the crops might show heavy and light crops during those periods. Some correspondence has been found between crops and sun spots, and he suggests that earth currents may be the cause, as they certainly correspond with the activity of the sun. He then discusses at some length the effect of light on plants, and offers an explanation of the action of light in producing chemical decomposition on the basis of a true resonance effect.

Dr. von Stephan on Electrical Progress.—The resumption meeting of the Berlin Elektrotechnischer Verein on October 22 was marked by the presence in the chair of Dr. von Stephan, the postmaster-general, who expressed the hope that the members had come back from their summer holidays considerably reinvigorated, that the summer had acted as a good accumulator for storing their reserve force, and that contacts and batteries, leads and resistances and insulators would be found in good order. He alluded with satisfaction to the very excellent results achieved by German electrical engineers in the past year. Electricity had, he said, won for itself a very high place, both from a practical and scientific point of view. Through its many-sided applicability to nearly every branch of industry, every year witnessed an increase in the number of fields in which it was indispensable. Even in uncivilised lands electricity was forcing its way, and the savage now receives his bible with one hand and takes the electric light with the other. Dr. Stephan, in conclusion, made enthusiastic reference to the electrical installations carried out abroad by German firms. Subsequently, Dr. O. Fröhlich read a paper on "A Device for Compensating the Effect of Electric Railways," the demonstrations in connections with which were postponed.

Electric Alarm for Railway Carriages Wanted. A correspondent calls attention to the necessity of fitting all railway carriages with some simple and efficient system of electric alarm with which to call the attention of the guard or engine-driver of the train. The lighting of trains that pass through long tunnels in the daytime is also insisted upon by the writer, who relates the experiences of three lady friends who travelled on Wednesday by a Great

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Northern train from Wakefield to Leeds. On the departure of the train, the ladies found themselves in the company of a man who was evidently insane. The train had left the platform before the discovery was made, and a run of about 20 minutes to Leeds without stopping was the sole alternative. His gestures and threats caused the lady passengers genuine alarm; but to add to their annoyance and risk a tunnel of some length intervened, and no light had been provided in the carriage. "It is idle," adds the writer, "for the railway authorities to call attention to their cord of communication with the guard, for all alike must recognise the utter futility of such means of alarm under circumstances of danger such as this; for the person who sits at the right-hand window can obtain full control over this communication, and the person in this case was the lunatic in question." Probably the Great Northern Company may soon find it advisable to equip more of their trains with the electric light, which is so easily switched on or off as the train enters or leaves a tunnel.

Electric Heating.—Mr. A. F. Nagle, writing in *Cassier's Magazine*, says no electrical appliances "are looked upon by the public with more favour than those designed for electric heating. They are simple and neat in construction; perfectly free from dust, smoke, or ashes; and are easily managed, requiring no skill or special training or fitness for the work; in fact, a child can manage them. Altogether the electric system is an ideal one of heating, except for one thing—its cost." Mr. Nagle goes on to consider the latter in comparison with steam for house-heating. He estimates that the loss in conveying current to the heater will be about 5 per cent. Taking 90 per cent. as the efficiency of the generator, and 10 per cent. to represent the mechanical friction of the engine, we get down to 77 per cent. for the efficiency of the mechanism from engine to heater. But the efficiency of the engine will probably not exceed 13 per cent. of the energy contained in the steam, so that the ultimate efficiency is 10 per cent., whereas if the steam were used directly for heating the efficiency would be between 90 and 75 per cent. Worked out on the basis of coal consumption, the result is no better—the ratio coming out 11 to 1 in favour of steam, instead of 10 to 1. In practice, however, as an ordinary house-heating system has to be compared with a first-class electric generating plant, the ratio is really 2 to 1 in favour of steam. The cost of attention, etc., is not, however, estimated in either case, the above figures applying only to the coal bill.

Etheric Lighting. — The fundamental principle employed in the Moore system of "etheric" lighting, as the inventor prefers to call it, consists in generating electric waves or vibrations suitable for producing luminous effects by interrupting the flow of electric current through a circuit of induction in a high vacuum as contradistinguished from a partial vacuum or one in which the rarefaction has not been carried beyond the point suitable for exhibiting luminous effects. The electric waves or vibrations so generated are made to produce luminous effects by action upon a receiver containing a rarefied gas. In order to produce etheric or phosphorescent light there is required a high E.M.F. with a short wave-length. Heretofore high E.M.F.'s have been obtained by the utilisation of counter E.M.F., due to the breaking of a circuit of high induction; but the degree of the counter E.M.F., or the final voltage obtained, as is well known, depends very largely on the suddenness with which the circuit is disrupted. In Mr. Moore's apparatus the circuit through the magnet is disrupted at a contact placed within a vacuum tube, the interposing dielectric being, instead of air, which is a comparatively good conductor, a vacuum of almost infinitely high resistance and inserted in the circuit in a minimum space of time. Another reason for the results obtained is that, as the vibrator is within a vacuum, it is free to move. That is, it has no air resistance, and practically it is proved that it vibrates at a rate of between 4,000 and 5,000 vibrations—that is, three or four times as fast as the same vibrator would vibrate in the open air.

The Training of the Young Engineer.—The inaugural meeting of the fifteenth session of the Institution of Junior Engineers was held on November 1 at the Westminster Palace Hotel. In the absence abroad of the retiring president, Mr. Alexander Siemens, the chair was taken by Prof. A. B. W. Kennedy, F.R.S., past-president. It was announced that Mr. Archibald Denny had been elected president, Lord Kelvin vice-president, and Mr. Hiram S. Maxim honorary member of the institution. The Chairman, in acknowledging a vote of thanks to Mr. Siemens and himself, said that he had the honour to be the first president of the institution. Since the year 1884 its membership had increased something like seven-fold, while its subscriptions had increased twenty-fold. The new president's address was devoted to an examination of the qualities and training necessary to a young engineer in order that he might be successful in his profession. He thought that all young men should start with a good English education, with Latin and Greek curtailed to the minimum possible amount. Mathematics, and the elements of mechanics, chemistry, and physics, should be thoroughly mastered, so that at the age of 16, or at the latest 17 provided the boy's physique was fairly developed, his apprenticeship might begin. The lad should spend the six summer months at the bench, and the six winter months at a first-class technical school or college. At the end of three years, or four years at the most, the youth should be quite ready for the drawing office; the shorter period should suffice in the shipbuilding yard, and the longer period for the marine engineer.

Copper Safety Fuses.—In the current number of the *Transactions* of the American Institute of Electrical Engineers are printed some remarks made by Mr. C. P. Steinmetz at the Niagara meeting of the institute, criticising the statement that copper fuses are superior to any other fuse. This statement Mr. Steinmetz believed to be based upon a misunderstanding of the object of the fuse. A fuse, he said, is not in circuit only to open the circuit at a dead short-circuit. It is not even the best means for this. A magnetic circuit-breaker, or any other circuit-breaker, is far superior to guard against short-circuits, because fuses will not always open on dead short-circuit with unlimited power behind. The object of a fuse is to open the circuit if the loads exceed the carrying capacity of the lines or the rated load. In this case, where the fuse is used in its proper place to guard against excessive load by cutting out the circuit at, say, 50 per cent. overload, the comparison between copper and lead fuses leads to quite different conclusions. Neither of these fuses will blow with such an explosion as on dead short-circuit. Both will be perfectly safe to open the circuit, but as soon as the load approaches fusing point the copper fuse will be red hot, due to the high melting point of the copper, and thus liable to ignite dust or other combustible material, and set the building on fire. Thus the lead fuse is preferred to the copper fuse, not because it behaves better under a dead short-circuit, but because it opens the circuit and blows a temperature below that which will ignite combustible material, and for this reason copper or any other metal with a high melting point is absolutely unsuitable for fuses,

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except in particular instances where the conditions are such that it can ignite nothing.

The Propagation of the Magnetism of Iron.—Herr W. Peukert discusses this subject. When a long straight iron bar is excited by a magnetising coil situated at the centre, the lines of force, all of which pass through the coil, do not keep in the iron up to its extreme end, but emerge into the air at all points along its length, so that the induction in the bar falls off continuously as the distance from the central source of magnetisation is increased. With a periodically varying magnetising force the same effect is produced, and, moreover, the corresponding periodic changes in the induction induce eddy currents in the iron. These cause a lag in the phase of the induction, which increases as the end of the bar is approached. Experimental proof of this was carried out on rods of about one metre length of wrought and cast iron, and on a large bundle of soft iron wires of 1mm. diameter. The induction at various points was measured by search coils placed at intervals on the bar, and readings of the instantaneous values of the induction were taken through a complete period for each coil. The readings were obtained by means of a contact-maker fixed on the alternating-current dynamo used for exciting the magnetising coil, the momentary currents being indicated by a Wiedemann galvanometer. Magnetomotive forces of 288 and 1,306 ampere-turns were used. The curves of induced E.M.F. obtained from all three samples show a shift of phase which increases with the distance of the search coil from the centre of the bar, both at the lower and at the higher values of the induction. The curves are not symmetrical with the zero axis, the difference being attributed to residual magnetism. There is no marked difference between the changes of phase produced in the solid and in the laminated specimens, the amount of shift not being sufficiently clearly defined to show any distinct difference. The magnitude of the deflections continuously falls off along the bar, showing the diminution in the induction.

The Trend of Electrical Development.—In years gone by, remarks *Electricity* of New York, almost the entire energy of investigators into electrical science was devoted to the improvement of the primary battery. There was indeed reason for this in that its efficiency was comparable to that of the steam-engine and far in advance of any known methods of obtaining any available energy from fuel. Its drawbacks, however, were many. The fuel, which was zinc, and the atmosphere in which it was consumed, which was the acid or saline solution, were far more expensive than coal and atmospheric oxygen, and the care required to keep the batteries in working order was excessive and burdensome. It seemed very possible, however, to so improve the details of the battery as to render its care less irksome, and invention turned its attention with considerable success in that direction. How to produce a cheaper fuel and atmosphere, however, was not so apparent, and practically no progress was made in that direction. With the advent of dynamo electric machines producing electricity from ordinary coal and atmospheric oxygen through the intermediary of the boiler and steam-engine, notwithstanding an inefficiency of over 90 per cent. as against about 20, the primary battery came into disfavour, and those who continued the investigation of the great problem connected with it became themselves the subject of obloquy and derision. The dynamo electric machine, the journal considers, has now been developed so nearly to its theoretical limit as to leave no reasonable expectation of any further advances in the way of efficiency. In the meantime electro-chemical science has been advancing with giant strides, and many metallurgical operations which before were dependent directly upon the combustion of coal are now performed more quickly and more cheaply by the intervention of the boiler, engine, and dynamo. It is the dynamo itself that has rendered this possible, and the next step will be that the dynamo by familiarising us with electro-chemical processes will enable us to produce electricity itself by electro-chemical processes. There seems to be no question, in the opinion of our contemporary, that galvanism is to be re-enthroned in the near future. It will not entirely supplant dynamo electricity, however, for the latter will always have its field of usefulness, and there will always doubtless be conditions where, even with its 90 per cent. inefficiency, it will be cheaper than the battery method, but it is not to continue to hold undisputed sway as it has done during the past decade and more. It is idle, the writer imagines, to suppose that any method can be devised of consuming zinc to compete with coal. The economic possibilities of batteries consuming zinc have been almost as nearly reached as have those of the dynamo, and no further progress can reasonably be expected in this direction. Nor is it reasonable to expect that electricity will be generated by chemical means directly from coal. The fuel for our boilers requires some preparation before it can be economically employed there, and it is to be anticipated that it will require some special preparation to adapt it to the direct production of electricity. Under our boilers the admission of atmospheric oxygen has to be carefully regulated, else the results obtained are unsatisfactory. It is not unreasonable, then, to expect that the method of burning our fuel for direct electrical production will have to be carefully considered. The direct production of electricity from fuel does not therefore mean the burning of an unprepared fuel in an uncontrolled atmosphere, but means a proper preparation of both, and their especial adaptation, so that the latent energy may become manifest in the electrical instead of the heat form. These, the journal concludes, are all problems for the electro-chemist, and they are problems that are being attacked by so many vigorous thinkers that their solution must be in the order of things.

Brazilian Telegraphs.—The official report of the Brazilian Minister of Telegraphs to his Government in reply to the memorandum which Sir John Pender submitted to it has been published. The memorandum, it may be remembered, contained the bases of an agreement which Sir John Pender desired to conclude with the Government for the working of the submarine cables now belonging to the Western and Brazilian Telegraph Company in conjunction with those of the Brazilian Submarine Cable Company, of which he is the chairman. The Brazilian Government has virtually concluded arrangements for the purchase of the Western and Brazilian lines, which are laid along the coast of Brazil, and give communication with the other republics in South America, and Sir John Pender, in his memorandum, intimated that unless his proposals were accepted the benefits of that purchase would be to a great extent lost by the laying of a competing cable direct to the River Plate, thereby avoiding the present route over the Government's proposed acquisition. The Minister deals at length with the facts alleged in the memorandum in connection with the past history of both undertakings; in effect it is claimed that full consideration has been shown in the past to the Brazilian Submarine Telegraph Company, while the conduct of the managers of that undertaking, together with the attitude now taken by Sir John Pender, warrants the suspicion with which his actions are obviously regarded in Brazilian Government circles. It is clear that if Sir John Pender's object be to prevent

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the purchase of the coast cables, he has adopted the very course most calculated to drive the Government into a speedy completion of their arrangements. The veiled threats in the memorandum, and the tone of the speeches since delivered in London, are not of a character that a responsible Government can submit to from a private individual, even of the high standing of the head of the telegraph "ring." One other point in the dispute of a personal character may be mentioned. The Minister of Telegraphs writes in his report: "With respect to the complaint that Despecher, Sir John Pender's agent, had not received the consideration which was to have been expected, I have to state that the latter was always received with the greatest courtesy by this Department under the orders of your predecessor, and if his mission was negative in its results, this was due to his not conforming with the original requirements of the concession." In commenting upon this report the *Daily News* says: "The question of the respective benefits to the public and to the proprietors of the defeat or establishment of a cable monopoly is, however, a matter of less immediate concern in this connection than the international complications which have arisen through the taking possession and present retention of the island of Trinidad by the British Government, ostensibly in connection with the cable schemes of Sir John Pender. A perusal of the document now under discussion shows that the Brazilian Government obviously has special reasons for attaching importance to the island, the possession of which is regarded as the key to the telegraphic situation. If this isolated barren rock be Brazilian territory, it cannot be utilised for cable communication in opposition to the existing systems, the Government having two years ago given a guarantee against such competition. The possession by a foreign Power would facilitate the rival schemes with which Sir John Pender threatens the authorities at Rio, with the alternative of confirming his own monopoly. British capital and the good relations which have hitherto subsisted between this country and Brazil are seriously imperilled for no better cause than a not too creditable telegraphic intrigue. A careful consideration of the circumstances, as embodied in the document to which we have alluded, may assist the Government to withdraw from what would appear to be a false position. It was doubtless assumed under a misapprehension of some of the facts involved." An interesting sidelight is thrown on this affair by the correspondence between the Western and Brazilian and Brazilian Submarine Companies which appears in another column.

Protection from Lightning.—A circular of information bearing this title, by Mr. McAdie, of the United States Weather Bureau, is published as Bulletin No. 15 of the United States Department of Agriculture. The pamphlet is rich in statistics, and contains numerous practical deductions; it has illustrations of lightning conductors, of objects struck by lightning, and some photographs typical of lightning discharges. Among the more important and interesting statistics and deductions are the following: During the five years, 1890 to 1894, an average of 224 lives a year were lost in the United States due to violent wind storms, tornadoes, and lightning; during the nine years ending in 1893 there were in the United States 4,175 fires caused by lightning, representing a total loss of over 14,000,000dol.; during the 10 years ending in 1893, 2,679 barns, 129 churches, and 831 dwellings were struck by lightning; their geographical distribution is given; the loss of life and property in 1894 is discussed in detail; the region of the greatest number of thunderstorms is in the south-eastern part of the United States; an interesting result of the statistics is that there is a decreased liability to accident in thickly-settled communities, the risk in the country being five times as great as in the city; lightning rods are hardly necessary for dwelling-houses in city blocks, a considerable protection being afforded by the tin roofing, cornices, etc. If 1 represents the frequency of lightning strokes in a chalk formation, 2 will represent it for marl, 7 for clay, 9 for sand, and 22 for loam; the oak is the tree most frequently and the beech the one least frequently struck; the statistics show that the trees which are struck are not necessarily the most prominent, but rather those which are near ditches full of running water or near temporary watercourses. A theory of lightning conductors is discussed: the function of the lightning rod is twofold, that of conducting the charge to earth and that of preventing a disruptive discharge by silent neutralisation of the cloud electrification. Lord Kelvin, at the British Association meeting of 1888, stated that there is "very strong reason to feel that there is a very comfortable degree of security, if not of absolute safety, given to us by lightning conductors, made according to the present and orthodox rules." A set of rules for the erection and maintenance of rods is given: one should use a good iron or copper conductor, and if the latter, one weighing about six ounces to the foot, preferably in the form of tape; iron appears to be as efficient as copper, and it should weigh about 35oz. to the foot; a sheet of metal is better than a rod of the same cross-section; the nature of the locality will determine the need of a rod; the very best ground obtainable is a very poor one, and one can therefore not overdo the matter in the making of a good ground; the earth-plates should be buried in damp earth or running water; when the conductor is near water or gas mains it should be connected with them; the neighbourhood of small fusible gas-pipes and indoor gas-pipes should be avoided; the top of the rod should be protected from corrosion and rust; independent grounds are preferable to water and gas mains; clusters of points are recommended; chain or link conductors are of little use; very little faith is placed in so-called area protection; some uncertainty exists in regard to the return shock, which is caused by the inductive action of charged cloud on distant objects; regarding the indifference of lightning to the path of least resistance, Lodge says "it is simply hopeless to pretend to be able to make the lightning conductors so much the easier path that all others are out of question"; the path will depend largely on the character of the flash; while parts of a building protected by a rod may be struck, the majority of flashes in our latitude are not so intense but that a well-earthed lightning rod makes the most natural path; there are many instances, however, where buildings were struck below the rods; buildings may be damaged without having been struck at all, as by an induced spark near escaping gas; there is no good reason why a place once struck may not be struck again. It sometimes makes but little difference whether trees are higher than the adjoining buildings or not—the lightning may strike them indiscriminately; it is not judicious to stand under trees, in the doorways of barns, close to cattle, or near chimneys and fireplaces, but there is no reason to try to insulate oneself; small steel objects do not attract lightning; if a person is struck people should at once try to restore consciousness, as lightning often brings about suspended animation rather than death; instructions for resuscitation are reprinted. No better illustration of the value of lightning conductors can be had than the one on the Washington monument. It appears that a barn is more liable to be struck when filled with crops than when empty.

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THE WESTINGHOUSE UNDERGROUND SYSTEM FOR ELECTRIC TRACTION.

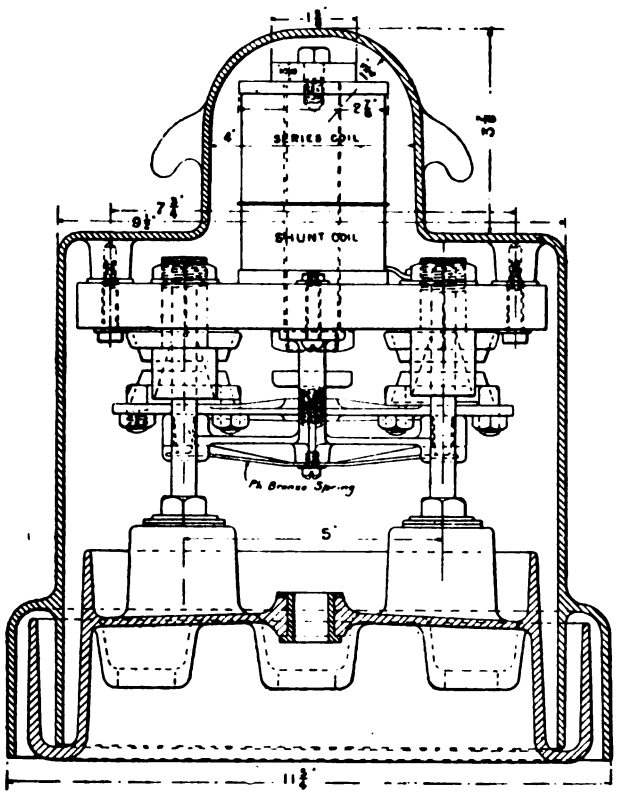
(Concluded from page 505.)

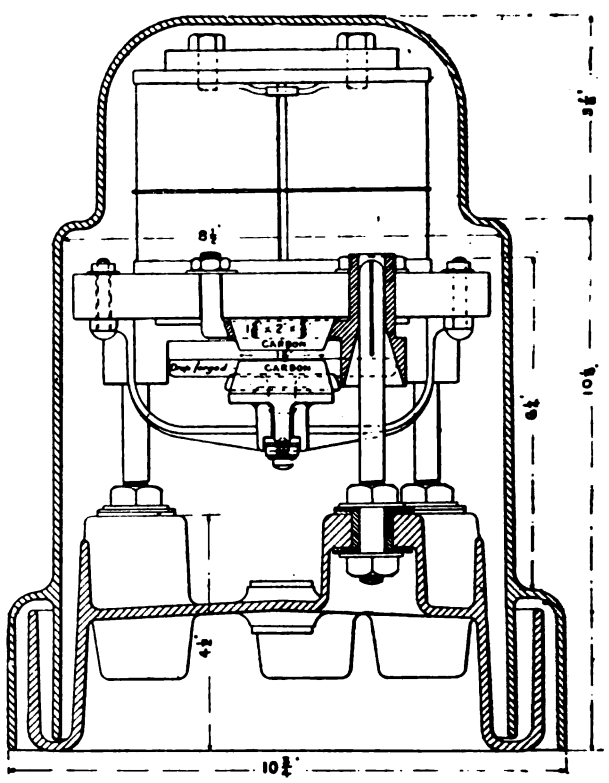
As promised in our list issue, we are now able to give an illustration of the automatic switching gear designed for the system described there. The apparatus has many points in its construction which are novel. The details of the switch, etc., can be seen in Figs. 4, 5, and 6, which represent a plan of the apparatus and two sectional elevations.

The electromagnet used has two coils—one of fine wire, which receives the current from the small battery carried by the car; the other of larger wire, which takes the current passing from the main to supply the motor on the car when contact is made. The action of this second coil is simply to reinforce that of the first coil, and to strengthen the pull of the electromagnet in order to secure a firmer contact. On this electromagnet being excited by the battery in the car its armature is attracted, thereby bringing into contact two sets of double carbon blocks. The carbon blocks mounted on the moving armature are connected together, while those fixed to the upper part of the mechanism are insulated from the frame. One of these carbons is connected to one of the points in the road through the thick wire of the series coil, and the other is connected to the main. It will thus be seen that when the four carbon blocks go together, the connection is made between the main wire and the third contact point. Carbon contacts are used, because they will not stick together by the action of the current, nor arc destructively when breaking the current accidentally. This switch is mounted in a cast-iron case similar to a diving-bell. The base on which this diving-bell fits has a circular groove, which is filled with oil.

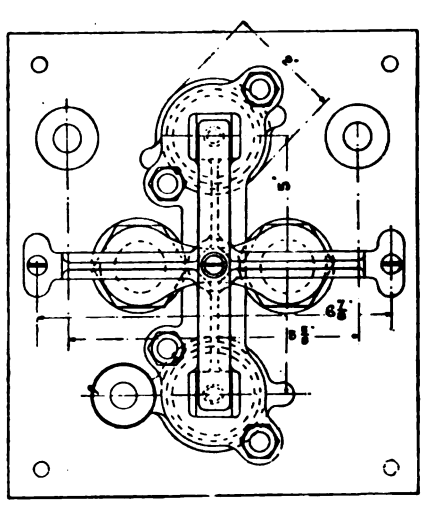
The mouth of the bell itself contains a somewhat smaller groove, so that when the two are placed together an S-shaped channel is formed, and a complete oil seal is obtained, which prevents the entrance of dirt or moisture. The base has knobs on it carrying insulated pins, which are permanently connected to the various wires on the surface of the road and the main wires. The pins have their heads split, and fit into holes the openings of which are tapered, so that the mere effect of placing the bell into position on its base will make all the contacts necessary for the switch; and in the event of the switch going wrong the bell can easily be lifted off and a new one placed in its position, such an operation occupying but the space of a few seconds.

The diving-bell construction and oil seal make an absolutely water-tight case for the switch, which will remain dry even if the whole surface of the road is covered with water. These bell switches are generally placed two in a manhole in a 6ft. way, one controlling the up line, and the other the down line. It can therefore be readily seen that the chances of leakage and accident to the wires are very much reduced, as by the construction of the switch shown, the insulation of the mains can be practically made as high as may be desired, and everything being buried underground no accidental damage can be done to the wires. Fig. 7 shows two sections through the contact points on the track. The contacts are of wrought iron set in earthenware blocks.





FIGS. 4, 5, AND 6.—Details of the Westinghouse Automatic Switch.



A SUCCESSFUL AND SIMPLE METHOD FOR PREVENTING ELECTROLYTIC DECOMPOSITION BY RAILWAY CURRENTS.*

BY MR. FOREE BAIN.

A great deal has recently been said in regard to the deleterious effects of railway circuits in their action on water-

* From the *Electrical World* (New York).

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pipes, etc., and several more or less complicated remedies have been suggested, some of such embracing special dynamos connected in various novel if not effective ways to special and additional circuits. All of such might meet with careful consideration if the evil could not be entirely cured and prevented by the simplest and most rational method, which is free for use without royalty, and which may be used by any one afflicted with the trouble to which this article refers. The remedy, in a nutshell, consists in having underground conducters equal or greater in current-carrying capacity than that of the overhead conductors, not considering the rails as a part of the circuit. The integrity of the underground circuit must be as carefully preserved as that of the overhead conductors. A failure in this may not lead to immediate disaster, as with the overhead conductors, but it will result in disaster postponed.

Local disintegration of uninsulated conductors laid in the ground is continually going on. The damp earth forms the electrolyte through which parasitic currents will flow between the copper conductors and other metallic bodies adjacent thereto, which are either electro-positive or electro-negative to the copper. This action is galvanic, and continues quite independent of the dynamo current flowing in the conductors, and constantly tends to change the carrying capacity of the underground conductors; added to this is the oxidising of the contacts, and the corroding action of other joints and contacts, all tending to increase the resistance of the circuit. Therefore, it may be seen that the carrying capacity of the underground leg of the circuit is constantly becoming smaller, so that it becomes necessary to start with it abundantly large, and to protect it against these effects as intelligently and as persistently as we maintain the insulation of the overhead conductors.

Local galvanic action, such as I here describe, is not that which damages the water-pipes or which makes enemies of our telephone friends, for it is only a small thief, the servant of time and the anti-fat of our underground circuits, reducing the carrying capacity of our meagre, niggardly provided underground conductors to such a degree that the current must stray away to water-pipes, gas-pipes, telephone lines, and other conductors which happen to be approximately in the path, and at many and divers points, leave such to again return to the rails or to other systems of pipes. In its ramifications it performs work by electrolytic decomposition at every point in the circuit where a marked difference of potential exists, and where the current passes from the underground piping where in contact with an electrolyte, such as damp earth.

Now, supposing an ideal construction in which the rails were electrically continuous, and of amply large carrying capacity and low resistance, so that there would be but a slight difference of potential between the extreme ends where the current enters and where it leaves them; when the maximum current is flowing, the path of the lowest resistance being through the rails themselves, then there would be no appreciable electrolytic decomposition of the water and gas pipes in the neighbourhood of such a road, for the reason that the legitimate circuit provides a much lower resistance than the extraneous conductors. The rails as electric conductors cannot, however, be depended upon in practice, and should not be considered as a part of the circuit for an electric railway system. There should be a sufficiently ample conductor in the return circuit, in addition to the rails, such conductor at least equaling the joint capacity of the trolley wires, the mains and feeders of the overhead leg of the circuit, in order to secure desirable results and maximum economy.

I have equipped in this manner several notable, important, and successful roads, which have been in successful operation for about five years, and which have been entirely free from causing electrolytic decomposition of water and gas pipes and any objectionable telephone disturbances. The rails were bonded in the usual manner, and a No. 0 copper wire was laid between the rails and connected by cross wires to each bond wire. A large stranded, uninsulated copper wire, in some instances as large as 1,000,000 circular mils, was laid just outside of one of the rails in a trench and connected to the central No. 0 copper conductor at intervals of every 100ft. or more, according to the traffic on that portion of the road. This large stranded conductor was thoroughly insulated in the following manner: A continuous trough made of 2in. pine lumber, previously boiled in fernolene, was constructed. This was made about ½in. larger all around than the conductor or conductors it was to contain; the trough was laid in a trench outside of and parallel with the rails, and deep enough to be below the street paving. The conductor was laid in the box, and the taps leading out were attached at desirable intervals. The conductor was supported from the bottom on small cross sticks of prepared wood at intervals of 5in. or 6in. The box or trough was then filled up with hot pitch, the top nailed on, and the trough covered over. The taps connected to the central conductor were thoroughly insulated. It is more convenient to lay the underground circuit whip-stock fashion than to follow the feeder plan. The ground terminal of the power plant was connected to this conductor, and not to the rails as usual. In one instance I noticed that the telephone service was greatly disturbed at one time when I connected the ground terminal at the power-house to the water-pipes for the purpose of testing the efficacy of the arrangement, and I also noticed that the disturbance disappeared at once as soon as the water-pipe connection was removed.

The value of a plan such as I have outlined is determined by its successful and continuous operation for a reasonable period of time, and I can therefore safely say that the

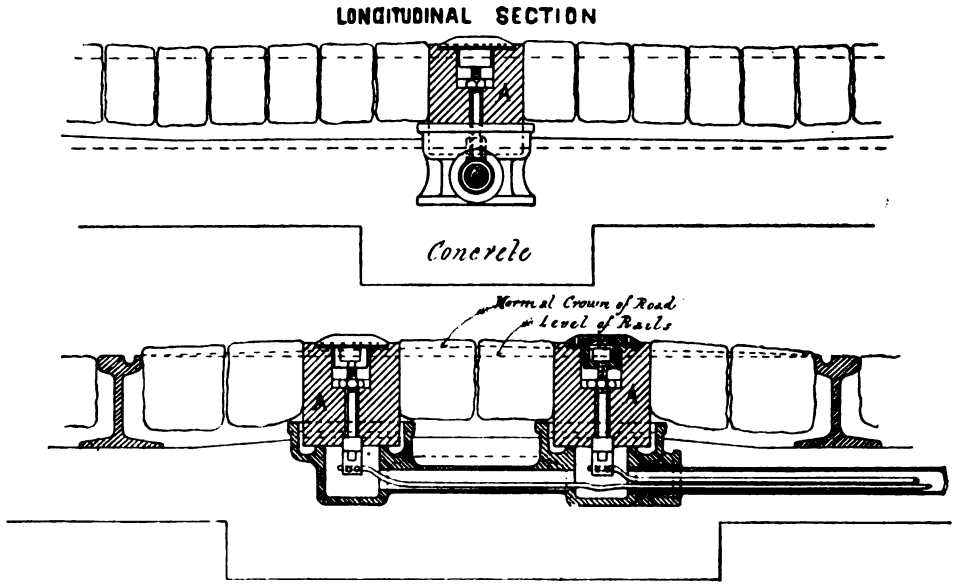

FIG. 7.—Sections through the Road Contacts.

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suggestions which I have offered have had a sufficient test in practical operation to render the plan valuable and reliable. The auxiliary track conductor may be placed on poles if desirable. In this case it may or may not be covered with insulation; being approximately at the same potential as the earth there is no danger, and the leakage will be negligible, and being removed from the ground the galvanic action is also nil.

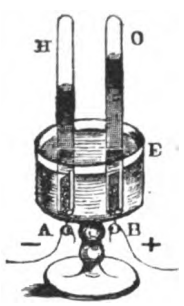
CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XV.—SIMPLE PRINCIPLES AND USE OF ELECTRIC MEASURING INSTRUMENTS—AMPERE-METERS, VOLTMETERS, DELICATE MIRROR GALVANOMETERS, RESISTANCE COILS.

(Specially Contributed.)

(Continued from page 508.)

Voltameter.—The apparatus used to decompose these compound liquids is called a voltameter, and consists in one form of a vessel, E, containing, say, acidulated water, in which are two strips of platinum—each strip of platinum is connected, as shown, to its respective battery terminal, A B.



In this case, when the connections are duly made with the battery, bubbles of gas will be given off from each platinum plate. In order to store and to enable an examination of these gases to be made, test tubes or similar tubes are first filled with the acidulated water, and carefully inverted over the platinum strips. Then, when the battery connections are made, the gases from the platinum strips collect in the tubes, H O, forcing out the liquid as they collect. In the case of acidulated water, one tube fills with gas at double the rate of the other. The reason of this is that water consists of two elements—hydrogen and oxygen. These two elements in the elemental state are gases, and so when the water is decomposed are given off and collected as gases. The combination water consists of *two* parts of hydrogen by volume and *one* part of oxygen by volume, so that the platinum strip giving off hydrogen gives off twice the volume of that gas as the other strip does oxygen. Chemists symbolise the composition of water as H_2O, meaning that two parts by volume of hydrogen combine with one part by volume of oxygen to form the combination known as water. It is not my intention, however, to enter into the chemistry of electrolysis, though, I may say, I believe it to be one of the most fascinating, one of the most important, and one of the least investigated phases of electrical work. *The* important point to which I wish to direct your attention, is that *similar quantities* of electric current always give rise to the same amount of chemical decomposition. Thus 10 amperes of current for one minute will decompose exactly the same amount of acidulated water as one ampere of current for 10 minutes. This brings me to another unit of importance, especially in electrolytic work,

The **ampere per second**, which is named the **coulomb**.

If C = amperes, and t = time in seconds,

then $C\,t$ = coulombs.

Terms used in Electric Decomposition:

Electrolysis—Chemical decomposition by the aid of an electric current.

Electrolytes—The chemical compounds capable of being electrically decomposed.

Electrodes—The ends of the conductors from the battery or other source to the electrolyte.

Anode—The electrode by which the current enters.

Kathode—The electrode by which the current leaves.

Ions—The products of electric decomposition.

Anions—The products of decomposition at the anode, sometimes called the negative ion.

Kations—The products of decomposition at the kathode, sometimes called the positive ion.

In the decomposition of water, hydrogen is found given off at the kathode, hence is called a kation. Similarly, when metallic solutions are decomposed the metals are deposited on the kathode, hence the metals are kations; while oxygen, chlorine, etc., are given off at the anode, hence are anions.

Quantitative Laws of Electrolysis—The current flowing through any section of a circuit is the same as that flowing through any other section, hence:

i. The amount of chemical action is the same at all points of the circuit.

ii. The amount of an ion liberated at an electrode in a given time is proportional to the quantity of the current—*i.e.*, as above stated—to the coulomb ($C\,t$).

iii. The weight of an ion liberated at an electrode in a given time is equal to the quantity of the current multiplied by the electro-chemical equivalent of the ion.

We have already seen (Lecture III.) that an ampere per second, or a coulomb, deposits from a solution of silver nitrate 0·001118 gramme during that time. Thus 0·001118 is the electro-chemical equivalent for silver. Similarly, 0 000010384 is the electro-chemical equivalent for hydrogen. Knowing one of these—say, that of hydrogen—other electro-chemical equivalents can be calculated.

To Calculate Electro-Chemical Equivalents.—

1. Experimentally determine that of hydrogen—that is, determine the weight of hydrogen liberated per coulomb. This is 0·000010384 gramme.
2. To obtain the electro-chemical equivalent of another element, multiply the electro-chemical equivalent of hydrogen by the *chemical* equivalent of the other element. Thus, the *chemical* equivalent of silver is 107·67, hence the electro-chemical equivalent of silver is

$$0{\cdot}000010384 \times 107\,67 = {\cdot}0011804528.$$

Electrolytic Action as a Practical Measurer.—From what has been said it ought to be seen how electrolysis can be used to measure coulombs—that is, ampere-seconds—for

$$\text{Coulombs} = \frac{\text{weight of metal deposited in grammes}}{\text{electro-chemical equivalent of the metal}}$$

Thus, if silver is deposited, then

$$\text{Coulombs} = \frac{\text{weight of silver deposited in grammes}}{0{\cdot}00118}$$

If copper is deposited, then

$$\text{Coulombs} = \frac{\text{weight of copper deposited in grammes}}{0\,000328.}$$

However, for practical purposes—that is, for electric lighting or power work—the electrolytic method of measurement is not widely adopted. Too many errors are likely to creep in connected with time, weight, temperatures, checks, and inspection, although Mr. Edison has introduced and brought to considerable perfection a measuring instrument of this kind.

Electrical engineers use energy during intervals of time, or, they use power.

The Board of Trade unit is the kilowatt-hour—that is, 1,000 watts per hour.

A watt-hour is 3,600 volt-coulombs; for a coulomb is an ampere per second.

A kilowatt-hour will therefore

= 1,000 × 3,600 volt-coulombs.

= 3,600,000 volt-coulombs.

So that if in distributing electric energy we maintain the volts constant, knowing the voltage and determining the

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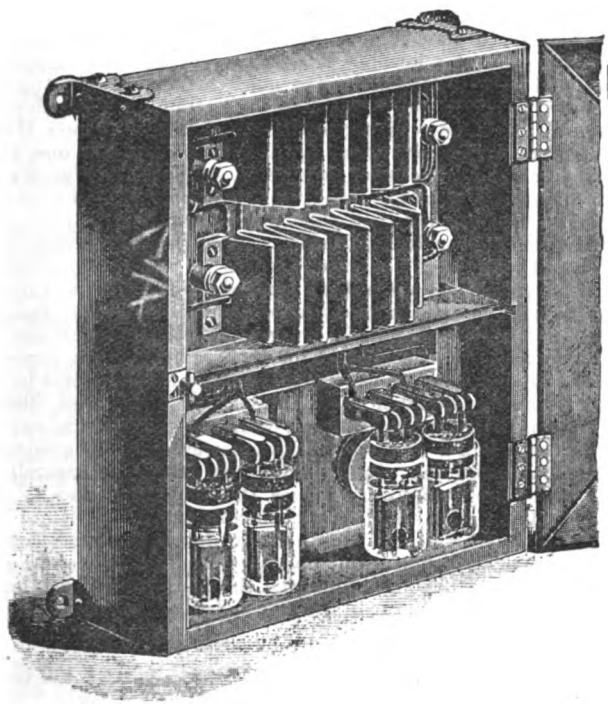
coulombs, we can find the Board of Trade units; and if the charge per Board of Trade unit is, say, 6d., the user's bill is easily made out. Unfortunately for this kind of measuring instrument, the voltage is rarely, or never, constant over any length of time.

Edison's Electrolytical Meter.—A recent form is herewith illustrated. On the lower shelf are four voltameters



with plates of pure zinc alloyed with 2 per cent. of mercury in a solution of pure zinc sulphate. The voltameters are shunts on the circuit so arranged in order to use only a small fraction of the total current, the main current going through the zigzag German-silver resistance on the upper shelf. In order to get rid of the disadvantages arising from variations in temperature, a copper coil resistance is put in the shunt circuit. The variation of resistance of the German silver is little with the variation of temperature, and that of the copper coil increases or decreases as that of the zinc sulphate solution decreases or increases, so compensating the resistances and keeping the total resistance on the whole fairly constant. The kathode plates are carefully weighed each month to know the number of coulombs, or of Board of Trade units, to be charged to the customer.

$$\text{Coulombs} = \frac{\text{weight of zinc deposited in grammes}}{0{\cdot}000337}.$$

ELECTRO-CHEMICAL EQUIVALENTS.

Hydrogen	0·0000104
Gold	0 0006791
Silver	0 0011181
Copper (cupric)	0 0003281
Zinc	0 0003369
Lead	0 0010716

A formula may be given for the weight of metal deposited in time, t, by a constant current, C.

Let E.C.Q. = electro-chemical equivalent,

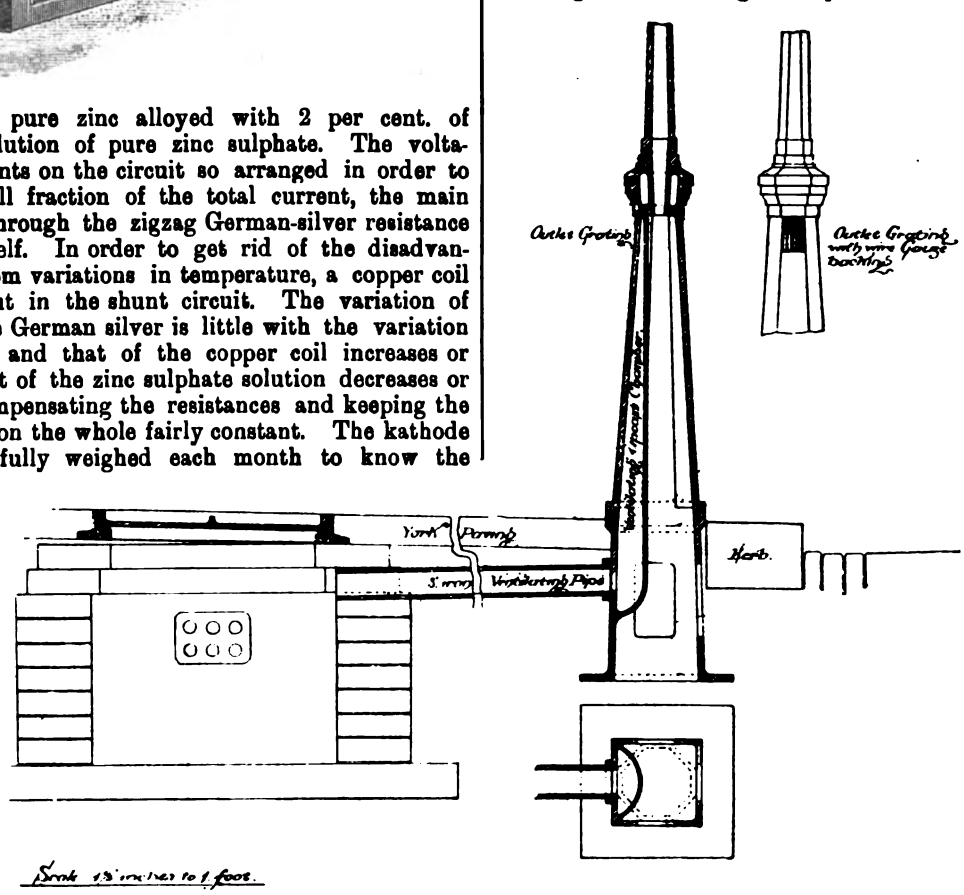
then

E.C.Q. (of metal, m) $\times$ Ct = w (weight in grammes).

WEAVER'S VENTILATING LAMP-POST.

The explosions which have taken place from various causes in electric light distributing boxes have called attention to means for preventing such explosions. One of the simplest, best, and least expensive which has come before our notice is that designed by Mr. W. Weaver, C.E., chief surveyor of Kensington. The designer has utilised his extensive knowledge of what may be termed street work in towns, and, instead of interfering in any shape or form with the curbed path or street, prefers ventilation through a specially designed lamp-post. This obviates increase of obstruction and interference with the public highways necessitated by the fixing of special dwarf ventilating posts, perforated gratings, and other suggested methods.

Mr. Weaver's post, as will be seen from the illustration, is extremely simple, and differs only from ordinary lamp columns by having an inner chamber cast in the lower half of the column, with a ventilating outlet grating at the top of the chamber, and a collar at the bottom for receiving a pipe laid from the box or culvert to be ventilated. The outlet gratings, which can be made of various sizes, are protected with gauze to prevent back-firing. The posts are being used extensively in Kensington, the Vestry allowing the electric light companies £1 for each ordinary lamp-post (worth £1. 15s.) removed and delivered to them, and fixing and making good round the special posts free of charge. The agents for the post (which is provisionally protected) are the Safety Tread Syndicate.



Weaver's Ventilating Lamp-post.

HIGH-VOLTAGE LAMPS.

We have received from Messrs. G. Straus and Co., Limited, of 130, Queen Victoria-street, London, E.C., and Schwechat, Vienna, their catalogue of incandescent lamps and accessories. We note that in the lamps listed the

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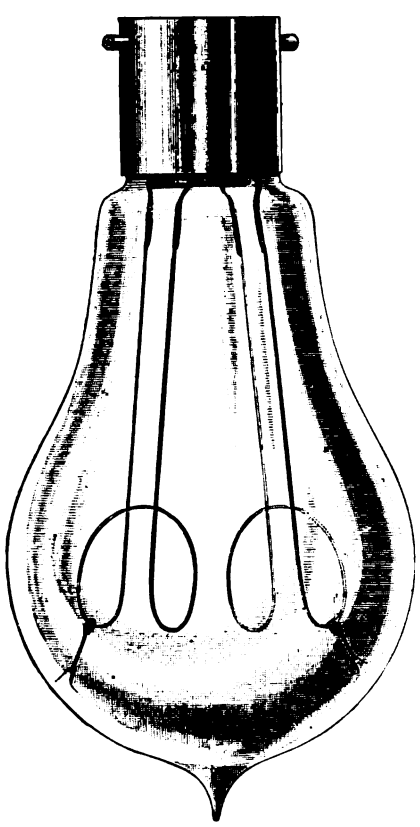
candle-powers range from ¼ to 1,800, the voltage from 1 to 280, the watts from 1½ to 3½ watts per candle-power. Especially classified are the following lamps: "Long Life," or 3½-watt lamps; "High Efficiency," 2½-watt lamps; ditto, 1½-watt lamps; low candle-power, or battery lamps, for small accumulators, for decorative, dental, surgical, and microscopic purposes; high candle-power lamps; high-voltage lamps, of 8 c.p. and upwards; fancy tubular, olive, crinkled, grooved, festooned, filigree, conical spirola, candle flame and flat lamps, switch lamps and focus lamps; and illustrations are given of 34 various sockets which this firm supply.

We illustrate herewith a specimen of the Straus high-voltage lamp. The firm claim that, with their special carbons, even lamps of from 8 c.p. to 10 c.p. can be supplied with the same efficiency and durability as at the usual voltage of 100, and they reproduce in this catalogue a *fac simile* of a letter from Mr. S. W. Baynes, dated Bradford electrical engineer's office, July 4, 1895, in which he says: "I put on test about 12 or 14 of the 230-volt 16-c.p. lamps you originally supplied. They were burnt continuously for over 3,000 hours without a single breakage. The average watts per candle-power was about 3·2 and 3·1



during the early stages of the test. On examining the bulb after so long a test you could scarcely tell that the lamps had been in use, there being little or no deposit of carbon on the glass."

The establishment at Schwechat, near Vienna, where these lamps are manufactured, consists of the arc-lamp carbon works of Messrs. Schiff, Jordan, and Co., and the printing and colour lithographic works of Messrs. Schiff, Srpek, and Co., with common offices, etc. Soot is used in both trades, and the soot furnaces form an important part of the works plant. The joint establishment comprises some 30 buildings, covering an area of about 20,000 square metres, and includes houses for the officials and artisans employed. In the testing building, 60 arc lamps, of both Austrian and foreign manufacture and of various systems, are used for testing each brand of carbon. The machinery is for the greater part of English origin. For supplying power there are two boilers and a 360-h.p. compound steam-engine. The transmission of power from one works to another and the lighting of the whole establishment is electrical. Electric accident alarms and electric ventilators are also provided. In addition to the employés' houses, there are dining-rooms, baths for males and females, and an ambulance and first-aid room. The annual capacity of the carbon works is nearly 20,000,000 lineal feet.

THE ARC LIGHT.*

BY PROF. SILVANUS P. THOMPSON, D SC., F.R.S.

LECTURE I.

Physics of the Arc.

It is narrated of Faraday that he had a particular dislike for what he called "doubtful knowledge"; and it was one of his great achievements in electrical researches to clear up a number of things that came under that category. Some small fact had been discovered, it was obscure, it was not correlated to anything else. So long as it was not correlated to anything else, and not explained, it was unsatisfactory. And though science has gone on since Faraday's time, has developed, extended itself, become correlated all round, while now there are a hundred workers where formerly there was but one, still there are some branches of science in which knowledge is still in a very doubtful state. Into the category of doubtful knowledge I venture to put that phenomenon which was discovered by Humphry Davy during the last year of the old century, and received the name of "the arc."

Although arc lamps are to be counted by the million, though the arc light is used publicly in every town and city, though electrical engineers handle it every day, yet it still remains to be true that on the subject of the arc itself as a physical phenomenon, those of us who know most feel ourselves to be very ignorant. So much is still obscure and unknown, that—in spite of the researches of many workers—the physical nature of the arc is still a mystery. Many, however, of the complications that beset the enquiry have been gradually unravelled, and every fresh discovery brings the workers nearer to the explanation of that which is still unexplained.

To the physics of the arc, then, we devote this first lecture of the present course; the optics of the arc will claim our attention in the second; while the third lecture will deal with the recent developments in the mechanism of arc lamps.

Early Discoveries.

To introduce the subject of the physics of the arc I will begin at the beginning and briefly recapitulate the things which were discovered in the first instance. It is sometimes said—and you will find it repeated in text-books—that the discovery of the arc dates from about 1809. I venture, however, to put the date earlier. It was in June, 1800, that Volta wrote an account of his then newly-discovered pile to Sir Joseph Banks, the then president of the Royal Society. The pile having in that way been made public, a few workers in science immediately precipitated themselves upon that invention, and tried to find out all that could be found about voltaic piles. Amongst those who thus set to work to build voltaic piles for themselves was Humphry Davy, then apprentice with Dr. Beddoes, of Bristol. In September, 1800, Davy recounts how he was able to produce sparks that were visible in daylight from the discharge of his primitive pile; and he found in trying sparks between terminals of different materials that those sparks were of different degrees of brightness. Amongst other materials that he names, he mentions that the bright spark visible in daylight was obtained by using well-burnt charcoal. He found that to render charcoal well conducting it must be hard, dense, well burned, so as to be metallic in lustre, and, best of all, if it were suddenly quenched in quicksilver. This early experiment of Davy's is recounted in the October number of *Nicholson's Journal*, to which it was communicated in September. Within one year several other accounts are to be found. In the *Philosophical Magazine*, in the February number for 1801, Mr. Moyes, of Edinburgh, narrates how he had produced sparks in broad daylight from a pile with some 60 or 70 elements. Then we find Davy again (having in the meantime removed to London and become lecturer at the Royal Institution) describing, in the very first volume of the *Journal* of the Royal Institution, how he also had obtained sparks of vivid brightness, using still pieces of well-burned charcoal. He describes an apparatus for taking the spark in fluids, and he continued to show this in his lectures on electricity. In that same year—1801 or 1802—Tyndall records that "Davy showed the carbon light with a battery of 150 pairs of plates in the theatre of the Royal Institution." Some six or seven years ago I was hunting up in the British Museum, for an entirely different matter, some of the early numbers of the *Journal de Paris*, and in the course of that search I came across something I had not at all expected. Under the date 22 Ventôse, An X. (March 12, 1802), I found the following entry: "Le citoyen Robertson, auteur de la fantasmagorie, fait dans ce moment, des expériences intéressantes, et qui doivent sans doute avancer nos connoissances sur la *galvanisme*. Il viente de monter des piles métallique, au nombre de 2,500 plaques de zinc, et outant en cuivre rosette. Nous parlerons incessament de ces résultants, aussi que d'une experience nouvelle qu'il a faite hier avec deux charbons ardens. Le premier étant placé à la base d'une colonne de 120 élémens de zinc et argent, et le second communiquant avec le sommet de

* Cantor lectures delivered before the Society of Arts.

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la pile ; ils ont donné, au moment de leur réunion, un étincelle brilliante, d'une extrême blancheur, qui a été aperçue par toute la société. Le citoyen Robertson répétera cette expérience le 25."

This same Robertson was a Frenchman of Scotch extraction, whose name comes into the outskirts of science in two or three ways. He was the man who introduced the phantasmagoria, and visited London with it at a later date. It is also said that in the same year, 1802, two other persons showed the carbon light, a German of the name of Curtet, and Ritta, of Jena, the famous experimenter upon the polarisation of copper plates ; but the references are so scanty that one cannot verify the fact. But it is quite certain that in those two or three years of the century it became perfectly well known that a light could be produced in that fashion between two pieces of charcoal.

I may here take two pieces of charcoal well metallised, and connecting them to the wires from a powerful source of current I will perform Davy's fundamental experiment by putting them together, and then separating them to a distance of about $\frac{1}{10}$in. apart from one another, when at once we get this little flame of dazzling brightness between the two. The flame in this case is really very bright, both the tips of the carbons themselves shine brilliantly, and the flame itself, when using soft carbon of this kind, is very bright indeed. Holding the pencils horizontally, as Davy did, the flame is seen to take an arched form, as the result of the ascending air current. This circumstance originated the name arc, which we retain, though nowadays we hold the pencils vertically one above the other, and have no arch.

If anyone doubts still that the arc light was a known thing before before 1808, let him look at this book, John Cuthbertson's "Practical Electricity and Galvanism," published in 1807, wherein, on p. 260, there appears the following : "*Experiment* 209 : *Deflagration of Charcoal by Galvanic Action.*—The charcoal for this experiment must be made of some very close-grained wood, such as boxwood or lignum vitæ, well charred, cut into pieces about an inch long, one end being scraped to a point, and the other so that it can be held by a port-crayon fixed to the end of one of the directors ; then approaching the point of charcoal to the end of the other director, light will either appear or the charcoal will be set on fire. The particular management required should be obtained by trials. The light, when properly managed, exceeds any other artificial light ever yet produced."

Further on, at the last page of the book, the very last sentence runs as follows : "The quantity of electric fluid given out by the galvanic trough when compared with the quantity given out by an electric machine is worth attention. The deflagration of charcoal (experiment 209), which has been accomplished by the galvanic trough, has never been effected by common electricity."

Now, in those early years when Davy was showing this experiment at the Royal Institution, and other people were repeating it, there does not appear to have been any very careful distinction drawn between the mere spark obtained by breaking the circuit between the points and the continuous flame, which, as I have shown you, can be produced by putting the points together and then separating them. If I steady my hand on a stand and hold the points a little distance apart, I get a flame which persists, although the carbons no longer touch one another. If I merely put them together and separate them wide asunder, I get a momentary spark. It is not very clear from the records that the permanent flame, what we now call the arc, could be obtained ; it is rather implied than described. The term "deflagration," used by Cuthbertson to describe a phenomenon which could not, as he plainly says, be produced, as momentary sparks can, by "ordinary electricity," is decisive. However, from the year 1808, there is no question whatever on that point. It was in that year that Davy drew up a kind of circular, addressed to the managers of the Royal Institution, saying that he hoped great things in the relation of electricity to chemistry to come from the voltaic pile, and begging them, if possible, to provide the means for purchasing a much larger battery. As a matter of fact, that famous battery of 2,000 cells was obtained by private subscription, and with this battery of 2,000 cells it was that Davy produced the phenomenon that created so much attention—viz., the production of a permanent flame of a great length and dazzling brightness arching over from one piece of charcoal to the other. If one substitutes for the comparatively soft charcoal that Davy first used, and that the earlier experimenters used, one of the hard carbons of the modern sort, one can manage the flame a little more conveniently. It was well known from about 1820 that the hard carbon obtained from the inside of gas retorts was a really good conductor of electricity compared with charcoal and many other things. It was in that respect comparable to the metals, and, indeed, by Babbage and Herschel the hard retort carbon was actually classified amongst metals in conducting power. Hard retort carbons were introduced for the purpose of battery plates a little later by Walker, and about 1834 were used by Grove, when he wanted to employ nitric acid. He found that nitric acid would dissolve copper or iron or silver, such as had been used in some of the earlier voltaic cells, and he was compelled to employ some materials which nitric acid would not attack. He employed both platinum and retort carbon cut into slips. But his battery became known as a platinum battery, and when, in 1843, Bunsen returned to the matter and employed carbon, many people imagined that carbon was Bunsen's invention for the purpose. At any rate, the use of hard carbon was coming into use in the arts. Foucault, in 1843, found that hard carbon sawn in strips was a better material than charcoal for producing the arc light, and artificial carbons were being made. By this time Bunsen himself had suggested the moulding of materials for the making of battery plates. Several patents were taken out for making artificial carbons by Greener, Staite, and Jabez Church in England, and by Le Molt, Archereau, and several others in France. One finds, in fact, that the electrical industry was being provided with the very material required, a hard carbon of good conducting qualities. About 1844* Foucault definitely proposed the use of pencils of retort carbon for the purpose of making the arc light. It was in 1846 that the first mechanical arc lamp was combined by William Edward Staite. Staite was one of those men whose inventions miss fire by being much before their time. He not only devised the necessary mechanism for an arc lamp, but proposed, among other things, to use two carbons parallel to one another, exactly in the same fashion that Jablochkoff did some 30 years later. Staite made a number of suggestions and improvements in detail, but does not seem to have worked much at the phenomena of the arc itself. Others, however, worked at it ; Grove, the sole survivor of all the men of that time, happily still with us, not then a judge, made some experiments on the loss of weight of the carbons, to find out how much carbon was consumed by the light in a given time. He also tried other materials than carbon, and found that the addition of volatile matters, such as sodium or potassium or their salts, increased the length to which the flame could be drawn out without breaking when supplied from a given battery. Daniell made some experiments, and found, amongst other things, that if you took your carbons and produced the arcs and let the tips get very hot, and then separated them so that the light goes out, and bring them near together, they still do not light unless you bring them into actual contact for an instant. But Daniell found that they could be made to relight by simply passing the spark from a Leyden jar discharge across—to begin the discharge, as it were. This was rediscovered by several persons later : Herschel, Van Breda, and Fusinieri all claimed to have discovered the rekindling of the arc by means of a spark from a jar. I here repeat the experiment, using a little Wimshurst influence machine to charge a suitable jar. Even Hertz waves can kindle the arc under favourable circumstances. De la Rive experimented with the arc, and examined various other phenomena, including the beautiful rotation of the arc round an iron pole, under the influence of magnetism, which had first been observed by Walker. Foucault, in 1844, made the observation that if the current was passed to form an arc between carbon and silver the arc was unstable ; whereas if the arrangement was reversed, so that the current flowed from silver to carbon, a long and stable arc was produced, giving out that magnificent green light which is characteristic of the spectrum of silver. He made the acute suggestion that the stability of the arc depended on the volatility of the material used as poles. He also drew attention to the action of the heat of the arc in metamorphosing retort carbon from the anthracitic into the graphitic state.

Before I go any further I may mention several additional points that were discovered in those early years. One of the first things Davy discovered was that the arc would burn under liquids. I will take these two carbon pencils and dip them into a vessel containing paraffin oil. On touching them together and separating them, I obtain a fitful, uncertain light ; there is a great deal of heat produced and it gives off vapour, but as long as the oil itself remains cool, there is no fear of the vapour taking fire. The light is also toned down to a more agreeable golden tint than is the case when one takes the arc in air. If I put these carbons down into water, and in the same way make contact, I get a whiter arc, which also is still more fitful. A quantity of gas is given off, some of which is mere steam, which condenses very rapidly, some is hydrogen, some is oxygen, and there are some compounds of carbon and oxygen also given off.

Arcs Between Metal Electrodes.

Returning to the arc in air, if I were to replace one of the two carbons by a bit of metal, I should get a very different effect. It is impossible to get a very steady arc between two pieces of metal, or even between a piece of carbon and a piece of metal. The kind of arc one gets depends very much on the metal one uses, and also on whether one is employing a metal as a positive or a negative electrode. Here, for instance, I am using a carbon rod for one electrode, and a bundle of iron rods for the other. There is an arc between the iron and the carbon, and the iron deflagrates off in a beautiful way in a fountain of ruddy sparks. It looks much more dangerous than it really is. If I take

* *Comptes Rendus*, xviii., p. 696, 1844.

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copper I get a very uncertain and flickering light, while the arc is of one colour if I employ the carbon as the negative pole, and another colour if I employ it as a positive pole. The copper disintegrates off more readily if it is made the positive pole than if it is made the negative pole. I am now employing solid iron; it does not deflagrate so much as the iron wire that I had before. Now I will take zinc, and I obtain this horrible roaring, hissing arc. But I may show you zinc under more favourable conditions. I will replace my metal electrodes by carbon ones, and take an ordinary stick of zinc, such as is used in battery cells. I will then make contact to it by touching it with these two carbons. If I make contact a moment with both, and then remove one of them, I shall have an arc between the carbon and the zinc. First, I will so operate that the zinc is the positive and the carbon negative. Then I will reverse the operation so as to have the zinc negative and the carbon positive. In one case the arc is much bluer than in the other, and it hisses much more. The arc is quieter if the carbon is positive, and the zinc negative than when the zinc is positive and the carbon negative. If I employ quicksilver in the same way, I shall obtain an arc which will differ in brightness according to whether the quicksilver is positive or negative. More vapour is given off when the quicksilver itself is the negative pole. The quicksilver now is positive—that is, a yellower light, and not so bright. The vapour is horribly poisonous, so we will not continue the experiment long. Prof. Way, an inventor of a mercurial arc lamp, 30 years ago lost his life by the poisonous fumes.

Arcs and Sparks.

Many of the earlier experimenters are extremely vague in the way they describe the arc. They do not give definite statements about the actual amount of the current they employed, and one can only judge of the E.M.F. at their disposal by counting the number of cells, and trying to find out what sort of cells they had. Modern science gives us the opportunity of being more precise. We can say exactly what E.M.F. we are using, and how much current we are actually sending through an arc. Such arcs as we have in modern practice require an E.M.F. of something more than 20 and something less than 70 volts—varying generally from 40 to 50 in the case where continuous currents are employed. Under those conditions the arc produced is a very different phenomenon from that which is produced by sending a much smaller current at a much higher pressure; for then the discharge takes the form of a thin spark. If one sends a spark or a succession of sparks from an induction coil, or from a large influence machine between two brass knobs at a distance from one another in the air, the discharge that one gets resembles the arc to some extent, but really is a very different phenomenon. The discharge one gets in vacuum tubes, between terminals of platinum, across the highly attenuated air, is again a different phenomenon. For in neither of those two cases does the material of which the electrodes are formed play any important part in the phenomenon. In these cases, as we now know, from the recent researches of Schuster and of J. J. Thomson, there occurs an electrolysis of the gaseous medium. What you produce in these cases is a discharge carried on by gaseous particles, which move about no doubt and pass to and fro and shine, but the light mainly comes from the volatile or gaseous particles, and does not come from the solid matter which constitutes the electrodes; whereas in the true arc itself the main light comes from the solid matter of the electrodes, and not from the gaseous matter of the flame in between. So in the production of the arc, a great deal depends—in fact, everything depends—on what that solid matter is. By universal consent carbon is found to be the only workable material. Moreover, the carbon is consumed at one or both of the electrodes during the continuance of the arc. This circumstance alone constitutes a distinction between the two cases. Now, the normal sort of arc produced between two carbon pencils is a thing that will engage our attention far more than any other arc, because it is the normal arc produced between two carbon pencils which is of industrial value. The others are mere curiosities, so to speak; they may hereafter have an industrial interest, but at present they have only an abstract scientific interest.

The Normal Arc.

What, then, are the conditions of producing the normal arc? We have carbon pencils of the purest and best carbon one can obtain. In most cases one wants a good conducting carbon, and a fairly hard one. The pencils must be put together, and after having been put together, they must be separated to the requisite distance; then the flame springs forth. In technical language, "the arc is struck." The tips become brilliantly white hot: one of them—viz., the positive one—burns away faster than the other. They assume different shapes, and the light is found to come almost entirely—by far the greater part of it, at any rate—from the white-hot end of the positive carbon.

To examine the conditions of the arc, a lens is arranged so as to throw a magnified image of the arc on the screen, where we can see the shape without being blinded. You will now see in the image on the screen what justifies my statement that the light does not come from the flame in between the two. The arc is now burning steadily, and silently; the current being sent in so as to flow downwards. The top carbon, which is therefore the positive electrode, is seen (Fig. 1) to have assumed a flattened form. That is the form assumed by the positive electrode, after being allowed to burn for a few minutes. There is a sort of slightly hollowed crater full of light. The current is coming out from that crater into the flame. There is an almost invisible pale-blue flame in between the carbons. The lower pencil has taken a more pointed form—a sort of peak having formed upon it. This negative peak also shines white hot, but we do not get so much light from it as from the other, nor is its light so white in quality. If I hold the carbons at a proper distance apart, you will notice that the arc burns quite quietly, and we have a silent flame. If I were to pull the top carbon up too much, and make the arc too long, it would begin to flame more and to roar, and would probably go out. On the other hand, if I make the arc too short, it would begin to hiss.

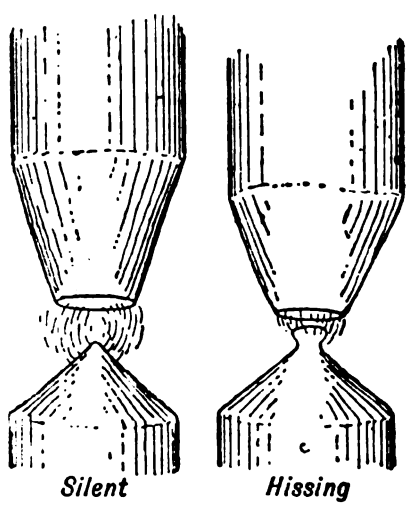

Fig. 1.

Sometimes it hisses persistently when the arc is too short. You then notice another phenomenon taking place—viz., that the negative tip, which ought to be burning away while keeping of a peaked shape, acquires little lumps. There are little projections, technically known as "mushrooms," which appear upon the peak. These mushrooms always occur when the arc is hissing. When the arc is burning silently the mushroom disappears, burning away until the negative carbon comes to its proper conical shape. In the case where alternating currents are used there is no such difference in shape between the two tips, as we shall see in due course. For the present I am considering the arc as produced when the current is of the continuous kind.

There is some difference in the circumstances attending the production of the normal arc. In America, the practice is to use two pencils of equal size, and of the same quality of solid carbon, usually coppered, and to work with arcs about 1-10in. long for a current of 10 amperes, many lamps being run in series. In England, where parallel running of lamps or groups of lamps is more common, the practice is to use as upper pencil a carbon of larger size than that employed for the lower pencil, and the upper carbon is usually "cored" (*i.e.*, made tubular and filled with a core of softer quality); while the length permitted the arc seldom exceeds 1-16in. to 1-12in.

Now, there is a great difference in properties between the arc that hisses and the arc that is silent. Not only have you this characteristic difference in shape, but the light is distributed differently from the surface. The quantity of current consumed, other things being equal, is different, and, in fact, as I shall show presently, the conditions are completely changed. Now, I would like you to contrast the effect produced in an arc burning quietly in that way with what one gets if one tries to form a current between two carbons in the same fashion at a distance from one another, using also a steady current, but employing much greater E.M.F. I have the means here, by a small continuous-current transformer, of generating a small current of about one ampere, at a pressure of 1,000 volts. The wires from that small continuous transformer are joined up to two carbons here. This long flame is obviously quite a different thing from what one gets by using the same amount of power in the form of a larger current at a smaller pressure. It is totally different from a 10-ampere arc at 100 volts, or a 20-ampere arc at 50 volts. There is a little streak of light, but that is really more of a flame colour, and the light from the carbon tips is comparatively insignificant.

Relations between Voltage, Resistance, and Length of Arc.

As soon as electricians began to think about making arc lamps, they had to discuss how much current to provide, and

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at what pressure. They had to decide as to the thickness of the carbons that was required, and what length they must allow. In fact, they had all manner of things to find out, and amongst the things they did experiment upon was what was the relation between the E.M.F., the current, the resistance, the length of the arc, and the size of the crater. They came across a very strange fact. If you consider the arc as a conductor, as a column of flame, or vapour conducting the current, you will find that it does not follow the laws of ordinary conductors; when you double its length it does not offer twice the resistance. It was a very puzzling fact, and the Swedish physicist Edlund, who first drew attention to this fact, thought it could be explained by supposing that in the arc itself there is a sort of polarisation as there is in a secondary battery when you are charging it, or as in a voltameter when you are decomposing water.* This polarisation manifests itself as a back E.M.F. opposing the current. Many researches have been made upon this matter, and I have tried to tabulate them:

FORMULÆ SUGGESTED FOR THE ARC.

Edlund	$r = a + b\,l$
Edlund	$V = C\,a + C\,b\,l$
Ayrton and Perry*	$V = 63 + 2{\cdot}1\,l$
Frölich	$V = m + n\,l$
S. P. Thompson	$V = m + \frac{n\,l}{C}$
Mrs. Ayrton†	$V = \alpha + \beta\,l + \frac{\gamma + \delta\,l}{C}$

* Their formula had a small correcting term here omitted.
† Added since the delivery of the lecture.

VALUES OF THE CONSTANTS m AND n (l BEING EXPRESSED IN MILLIMETRES).

Authority.	Date.	m.	n.
Ayrton and Perry	1882	63	2·1
Frölich	1883	39	1 8
Penkert	1885	35	1 9
Von Lang	1885	39	—
Von Lang	1887	37	—
Cross and Shepard	1886	37 to 39·7	1 9
Luggin	1887	40·04	1·77
Uppenborn	1888	40·1	2·24
Duncan and Rowland	1892	40·6	1 6

The E.M.F. applied to the arc to drive the current through we may call V. It may be otherwise described as the difference of potential across the carbons. Edlund found it to consist of two parts, a part independent of the length, and another proportional to the length, l, which symbol, in these formulæ, stands for the length in millimetres. As Edlund wrote the formula, it was an expression for the apparent resistance, r, in terms of the length, l, and two constants, a and b. This we may transform into an expression for the voltage, V, by multiplying both terms by the current, C, as in the second line in the above table of formulæ. The terms $C\,a$ and $C\,b$ are respectively the same things, as are denoted by m and n in the formula used by Frölich. They simply mean that the voltage consists of two parts, one a constant, the other varying (like a true resistance) with the length of the arc. Edlund did not himself determine the numerical value of those constants. They were not determined, as far as I know, until 1882 or 1883, and the earliest determination of that constant and the variable part is, so far as I know, due to Profs. Ayrton and Perry, but I do not understand the figures in their paper, because they make out that the constant part is 63 volts, and the part which is proportional to the length is in volts 55 times the length in inches, minus a correcting term (omitted from the formula for simplicity). The diagram which they gave, which corresponds to these figures, is to me entirely unintelligible, unless one supposes that in 1882 the voltmeters employed measured the voltages nearly twice too high. The other figures here given, with their dates, show a much more consistent tale: Frölich, in 1883, found the fixed part 39 volts, and the variable part to be 1·8 times the length of the arc in millimetres; Von Lang found 39 or 37 for the fixed part; Penkert found 35; Cross and Shepard 37 to 39·7; and Luggin over 40.

If we take 39 as about the average of these we shall not be very far wrong. Now, these 39 volts that one finds as the fixed part apparently having something to do with the properties of the carbons, for if you try arcs with any other material than carbon you get also a fixed number, but a very different one. And if you put into the carbons any other material to make them longer—for instance, soda, potash, alumina, or any metallic salt or metal—the maximum flame may be longer under different conditions, but as a matter of fact the light will be less for a given consumption of energy, and the fixed part of the voltage will also be less. Probably these low numbers of 35 and 37 are due to the presence of impurities in the carbons.

Now I should like to illustrate this matter by a diagram or two, in which some of these researches are set forth.

* Edlund considered that he had proved by experiment the existence of a measurable polarisation a fraction of a second after the current had been cut off. Although this persistent back E.M.F. was confirmed by Latchinoff, more recent experimenters, such as Stenger and Luggin, deny its existence.

Fig. 2 is a diagram illustrating the results of Frölich's researches. The length of the arc from the crater to the peak is plotted out horizontally, the voltage is plotted vertically. In the shortest arc which could be used without hissing Frölich found about 40 volts to be the amount of the E.M.F. which maintained the arc. As he lengthened the arc the voltage went up in this slightly irregular way. The irregularities may be due either to bad quality of carbon or to the circumstance that the current was not maintained constant, or possibly to the experiments being made too rapidly to allow the arc under each of the successive conditions of length to burn long enough

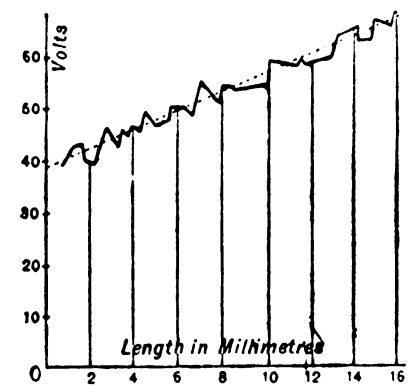

FIG. 2.

for the electrodes to assume the forms which they would acquire if left long enough. You will note that this curve slopes as though it intended to come down to 39, when the arc is of no length at all. To make a flame of this sort carry a current across from the positive to the negative carbon requires 39 volts, and the additional voltage indicated by the additional height to any point on the sloping line is that which is necessary to drive the current through the flame when the flame has various lengths. The longer the flame the more are the additional volts required.

Fig. 3 relates to some of the researches of Cross and Shepard. These researches are in many ways very full. For the first time statistics are given, not only for silent arcs, but for hissing ones. They made a number of determinations, trying various kinds of carbons, and also tried the effect of putting in different materials, such as soda and potash. The experiments shown in this figure relate to one particular kind of carbon, but using currents of different strengths; one set when using a current of five amperes, another when using 7·9 amperes, another 10 amperes; and they found that if they pursued the thing down, beginning with a long arc, and gradually shortening it, and

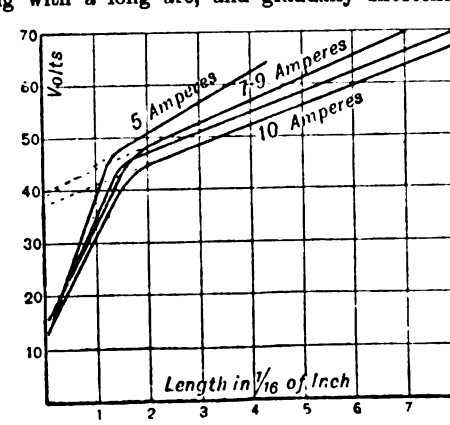

FIG. 3.

adjusting the current to the same amount as before, that the voltage fell, in all cases, as though it intended to go down to 39 volts, when the length is reduced to an appreciable amount. But as soon as the arc begins to hiss, then the curve changes; there is much less E.M.F. required to maintain the hissing arc than the silent arc, and the hissing arc appears to point somewhere to 15, 14, or 13. The hissing arc is very unsteady, however, and the exact form of the curve is uncertain here. To maintain a hissing arc wants very much less E.M.F. than to maintain a silent arc of no appreciable length; but in each case there is a part of the voltage fixed, and a variable part depending upon the length of the arc. I might give you, in similar curves, the results of nearly all these experimenters; but I should be only giving you the same thing over and over again.

I have found that, by gently blowing sideways on the arc, so as to cause it to take a long curved path, its resistance is increased: it then requires a higher voltage to maintain the current. The arc is indeed curiously sensitive to winds and draughts. It can quite easily be blown out like the flame of a candle.

(To be continued.)

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BRIGHTON TO ROTTINGDEAN.

From the very first inception of the project to the present time our readers have been made acquainted with the fortunes of the proposal to connect Brighton and Rottingdean by an electric tramway. Many years ago Mr. Volk designed and constructed an electric railway or tramway at Brighton which runs parallel to the Madeira-road. Knowing that a large summer traffic exists between Brighton and Rottingdean, he naturally looked into the matter of continuing the existing line to Rottingdean. That, however, was not deemed feasible, and another scheme for a line commencing but a few yards from the existing line was adopted, a company formed, and an Act of Parliament duly obtained. The proposed line will, for the greater part of the day, be under water, and at high spring tides the rails will be fourteen or fifteen feet below the surface. It may truly be described as a line under the sea. Ordinary tramway conditions do not apply in such a case. Originally it was thought that the car might be self-contained, carrying accumulators and motors, the latter communicating with the wheels of the car through gearing. We gather, from recent developments of the matter, that the idea of accumulators has been given up, and the scheme now favoured is to use the trolley system. Sanction for the erection of poles for this system has to be obtained from two or three authorities, and according to our information such sanction has been obtained for the line except the part under the jurisdiction of the Brighton authority. The most recent reports, discussions, and conclusions of this authority are given elsewhere in our columns. We have not to decide the question for Brighton, and we have no doubt but that permission will be given for the erection of the necessary poles. Usually a council will only consider a new scheme submitted for their approval as regards its being a nuisance or a danger. Brighton, however, must also consider the value of the completed scheme as an attraction to the town. We quite understand that a certain influential population of the town condemns everything in the way of attraction. They would have a quiet, residential, seaside resort; they would abolish excursions and excursionists. Those views are excellent in their way, but unfortunately it is too late now to keep Brighton select; and as a very large part of its wealth and prosperity is due to the expenditure of excursionists and visitors, their wishes must be considered. Now, visitors do not go to Brighton to sit in their hotels or lodging-houses, and there must be something for them to do. Some go the Devil's Dyke, some to Rottingdean, some on the water, some on the pier, and so on. Surely the ability to go to sea on a kind of moving pier-head, to be surrounded by water and pure air without danger of sea-sickness, to go on a unique kind of railway, forms just one of those attractions a popular sea-side place requires. Blackpool rejoices in its Winter Gardens, in its Eiffel tower, and will, ere long, rejoice in its big wheel; but then Blackpool acknowledges its indebtedness to visitors. Brighton, in part, wishes these visitors

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at the Dyke. Of course, the people on the spot are those in the best position to speak of nuisance and danger. From our own knowledge of this part of the Brighton beach, we should say that the nuisance from the proposed railway would be a minimum and the danger nil; while, again, the convenience would be great. No doubt a considerable part or weight of opposition to the scheme emanates from cab proprietors, and their views ought to be considered. They, no doubt, think that many carriages now hired to go to Rottingdean would not be required if the railway was in competition with them. This view is, we think, erroneous. The class of people who ride in carriages is not the class that ride in tramway cars. The increased accommodation would lead to increased numbers going to Rottingdean, and with increased accommodation there, in the shape of a good hotel, or good tea-gardens, the hire of carriages would probably in the long run increase rather than diminish. With regard to the details of the scheme. Being somewhat unique, it was but natural that some of the details would undergo alteration as the work progressed. This has occurred: the outside rails are now only eighteen feet apart, as against twenty-four feet originally contemplated; the car is increased in size and weight—hence the power for its propulsion is greater than was spoken of at first. Of all the means of supplying the fluctuating power required for tramway work, the electric trolley or conduit are the best. In this case the conduit is impossible, while the trolley is convenient and practical. By it you can convey all the fluctating power required. There is little noise and no nuisance attached to its use. We are pretty certain that neither compressed gas nor oil can be used with so little nuisance, and under the circumstances we doubt the practicability of using either gas or oil. From the æsthetic point of view, a post here and there is no more a nuisance than the mast of a boat or masts of boats in the foreground. From another point of view, Brighton having the credit of being the first place in this country where an electric tramway was inaugurated, should be glad to further add to its laurels in being the first to patronise another unique scheme of electric traction.

CITY AND GUILDS EXAMINATIONS REPORT.

The annual report of the Examinations Committee has been issued, and gives the usual statistics relating to classes, students, candidates, successes, and failures—marking time by reporting progress. A few sentences culled from the abstracts of examiners' reports are, however, of more interest than the statistics and conclusions founded thereon. In telegraphy and telephony, we are told, "the general results may, perhaps, be not considered to be so good as they were in 1894, yet the very satisfactory answers given by the best (a large number) of the candidates has rendered the examination a decidely creditable one." Often the candidate fails, not from want of knowledge, but from injudicious questions set by inexperienced examiners. In this case the fault is not with the examiners. The questions set are such as ought easily to be answered correctly, and if not satisfactorily answered by the candidate he ought to fail. The examiners in "Electric Lighting and Power" are somewhat hard upon their candidates, and here we think the fault is with the examiners themselves. Three or four of the questions are hardly of the kind we should expect to be set to young students at a preliminary examination. On the other hand, the candidate has a large selection of questions, and ought to be able to gain full marks without answering the doubtful ones. We always prefer the system of grouping questions on the same branch of the subject, and permitting a selection from each group. Otherwise, the candidate may gain full marks by ignoring altogether one or two important sections of the syllabus. In this particular paper the preliminary syllabus consists of nine sections. Why not put the questions in nine sections of three to a section or two to a section, giving full marks only when one at least in each section is correctly answered? The examiner in mechanical engineering makes one or two remarks very much to the point. We should be inclined to agree that many of the candidates have never been inside a workshop; also in the remarks that "there is considerable evidence of the attention of the candidate being strictly confined to his subdivided branch of work." It is a very difficult subject to suggest a remedy for this state of things. In many factories each man works year in and year out at one particular bench at one particular class of work. He becomes expert and experienced in this particular work, and knows practically nothing of the why and the wherefor of any other branch of work in the factory. Hence, in an examination, his special knowledge must be prominent, and his general knowledge usually of the weakest. We cannot say more on this subject at present, but would impress upon teachers the necessity of carefully studying the examiners' remarks, and taking to heart the lessons contained therein.

REVIEWS.

Polyphase Electric Currents. By SILVANUS P. THOMPSON, D Sc., B.A., F.R.S. E. and F. N. Spon.

This volume is the outcome of a series of lectures on the subject delivered at the Technical College, Finsbury, in the autumn of 1894. The author states that a good deal of matter has been added, and that he is indebted to the various firms and designers for valuable information as to recent progress and modern types of machines. From a cursory glance, the reader is at once struck by the numerous abstracts from various authorities on the subjects, and on reading more closely he will be confused by the absence of explanatory notes to many of these abstracts. In fact, while acknowledging the value of a volume collecting, as the one before us does, the opinions and theories of notable workers on polyphase currents, we hold that a text-book on a definite subject should at least show sufficient mark of the individuality of the author as to use the same methods of mathematical treatment in developing the different steps of the theory of the subject. In the present volume the elementary theory of the polyphase motor is commenced by a few pages of simple algebra, presumably by the author; we then pass to an abstract from Mr. Gisbert Kapp's last edition of "Electric Transmission of Energy," where graphical methods are employed; then the conclusions of Steinmetz

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are given without proof, and we pass on to the analytical theory based on the work of Mr. A. Potier, where integral and differential calculus is employed. Again, with the theory of monophase motors, we find three methods of treatment are employed, but here each is more complete in itself. The author commences by assuming that the reader already possesses technical knowledge, and hence much valuable space is saved. The first chapter deals with polyphase generators. It contains a good detailed description of the historical three-phase alternator used at Lauffen for the transmission of power to Frankfort. A dimensioned section of the revolving magnet and armature is given. Generators made by Brown and Boveri, the Oerlikon Company, and the Westinghouse Company are also illustrated, but the only other useful section shown is one of the 5,000 h.p. generator used at Niagara, which is taken from the *Journal* of the Institution of Electrical Engineers. It is in the next chapter, which is on the combination of polyphase currents, that the want of editing in the abstracts becomes more noticeable. Thus, on p. 50, a conclusion from a French book on the same subject is quoted to prove that a common return wire with the two-phase system increases the difference in phase between the two circuits. The reader is led to infer that the shifting in phase is due to the resistance of the line. We doubt the fact, and also are sure, that the illustration referred to as showing the connection—*i.e.*, Fig. 49 has no common return wire in it. Further on, when treating of the economy of copper with the various systems, we come to the following novel assertion on p. 55: "If, on the other hand, we take the maximum pressure between any two lines as a basis of comparison, we are now equating, not the risks of breakdown of the lines, but the risks of breakdown of the apparatus, machines, transformers, etc., in which the goodness of the insulation must be considered equal." No authority is given for this statement, so that we presume it is original, but the author does not bind himself by the "considered equal goodness." He proceeds to discuss the matter as though the risk of breakdown on the line was, after all, a function of the maximum pressure. A few pages after this we find an abstract from a paper by Mr. Goerges on the same subject which is unintelligible without more context. Chapter III., dealing with the properties of rotating fields, is historically interesting, and contains descriptions of some ingenious lecture models. This is followed by a chapter on the early development of polyphase motors, in which the author is quite at home. It commences with a description of Mr. Bailey's model, made in 1879, on the Arago principle, and gradually merges into a series of cuttings from patent specifications, illustrated by drawings taken from the same sources. The chapter ends with a good account of the Lauffen-Frankfort transmission of power scheme. The structure of polyphase motors is then discussed, and the useless endeavour to use the old terms "armature" and "field magnet" for rotary-current machines is wisely abandoned. The terms employed instead, "rotor" and "stator," must, of course, be considered to apply strictly to the moving and stationary parts respectively, although generally the alternating currents are supplied to the stator. Some useful hints on the practical construction of such motors are deduced from the commercial Continental types, one of these being the fact that the conductors on the rotor and stator should not be symmetrical in number or position. The chapter on the elementary theory of these motors we have referred to above. The theories given of the monophase motors, although perhaps the best available for abstraction, are not built on satisfactory assumptions. A few types of two and three phase transformers are described, and then the problem of a means of converting two-phase currents into three phase is treated. The method is simple, and consists of a ring of laminated iron provided with internal radial spokes. A rotary field being produced in the core, it follows by sequence that windings on different parts of the ring will have E.M.Fs. of varying phases produced in them, according to the relative positions of the coils. This idea is claimed by the author as being first published by him in February, 1894. It is a natural deduction from the patents of Bradley, Tesla, and others, for converting direct currents into alternating currents of different phases. We then come to a method by M. Désiré Korda which is stated, in the heading, p. 182, to convert monophase currents into currents of two or three phases. The next line contradicts this statement, and says it has the same function as the author's own device. From the mathematics, we gather that the inventor hoped to get the first result, but the apparatus as described will certainly give neither a constant phase-difference nor E.M.F. with varying loads. Perhaps the term "movable self-induction coil," which is said to be employed, does not mean that the coil is portable, but rather that the self-induction used is varied by hand as the load changes. The important subject of the measurement of polyphase power is dismissed by a chapter extending over 2½ pages, and the author then gives some notes on the design of rotary-field motors. As these are based on a motor actually made by the Oerlikon Company from the designs of Mr. C. E. L. Brown, which is illustrated by an end view and section, they repay close study; but it must be remembered that Mr. Brown's connection with the Oerlikon Company ceased in 1891, so the design cannot be up to date. The next chapters deal with the mechanical performances of these motors, and descriptionss of starting devices. The tables of tests are supplied by the makers themselves, and hence must be taken *cum grano salis*. The details of more recently-designed Brown motors which follow are decidedly useful. The appendix, which comes after the last chapter, contains 17 pages of references to literature on the subject from books and papers all over the world, and we note that the *Electrical Engineer* has not, in the author's opinion, added anything to the readable literature.

A second appendix, giving a list of patents, will be convenient should the legal right to manufacture polyphase currents ever be fought out in England.

COMPARATIVE COST OF ENERGY IN CENTRAL AND PRIVATE PLANTS.

Prof. Zickler discusses the comparative cost of electric energy from private installations and from central stations. Among a number of deductions he gives a diagram which shows that for an installation of 150 incandescent lamps of 16 c.p. consuming about 50 watts per candle, running for a mean of about 600 hours per year, it is cheaper to obtain the energy from a central station, while for 400 lamps of the same kind and running 1,000 hours per year, a private installation running with gas-motors is more economical. If there are 100 lamps running 1,000 hours per lamp per year, the diagram shows that for a consumption of one cubic metre of gas per horse-power hour the central station is more economical, for 0·9 cubic metre the two systems are alike, and if the consumption of gas is as low as 0·8 it is more economical to put up a private installation.

BRIGHTON AND ROTTINGDEAN TRAMWAY.

The following is a brief description of this line, which is now causing a considerable amount of discussion on the Brighton Town Council.

The line commences at the eastern end of the electric railway, Brighton, and extends a distance of three miles to the village of Rottingdean, a favourite summer resort. Here a small iron pier has been erected for the cars to run alongside; the pier is available for steamer traffic and promenading. At the Brighton end of the line an iron jetty has been erected, and a building containing commodious waiting-rooms and offices has been erected on it. The rails are laid on concrete block (made *in situ*) spaced about 3ft. apart, morticed into the sound rock, the height of the blocks varying with the irregularities of the shore. A shifting sand of very moderate depth covers the rock in places; the rails, however, have been laid sufficiently high to prevent any trouble from accumulations on the rails.

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The steepest gradient is 1 in 300, and the radius of curves 40 chains.

The line consists of four rails (54lb. per yard) laid as two tracks of 2ft. 8½in. in gauge, spaced 18ft. between outer rails, thus giving an effective gauge of 18ft. This is rendered necessary to give the required stability to the cars. The rails are secured by steel clips and bolts, the latter being embedded in concrete; oak blocks, through which the bolts pass, being placed between the rails and the concrete blocks. Tie-rods are also used every 10ft. on the straight and every 5ft. on the curves; heavy angle fishplates are used for the rail joints; the rails are in 30ft. lengths. The section of the track, and showing the proposed trolley poles, is shown in Fig. 1, which also shows a plan of the portion of the line within the boundary of the borough. The depth of water over the rails at high tide is about 15ft. Although the most violent gales experienced for many years occurred during the winter of 1894-5, no damage whatever was done to the permanent way, so the fact that it possesses ample strength to resist the force of the sea has been demonstrated in a satisfactory manner, and no accumulation of seaweed, etc., has taken place at any time.

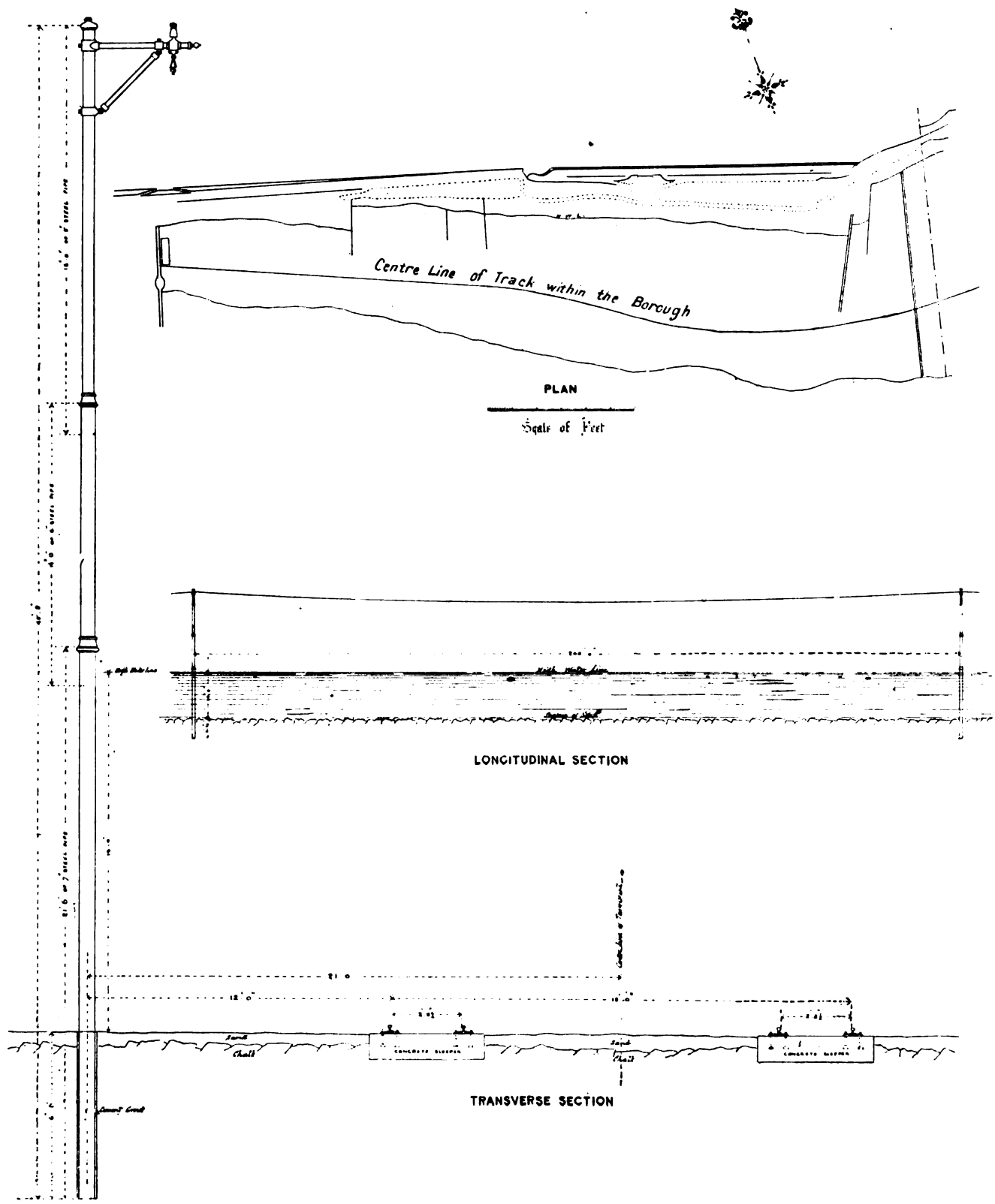

FIG. 1.—Sections of Track and Details of Trolley Pole Connections.

The line is now practically completed, but the work, being tidal, has been greatly delayed by bad weather.

The car (Fig. 2), which has been built by the Gloucester Railway Carriage Company, is a structure carried on 16 wheels, 33in. in diameter. The main deck for the passengers is at a height of 24ft. above the level of the rails. The four main legs are tubes of drawn steel, 11in. in diameter. At the bottom of each leg is placed a bogie truck having four wheels, the outside of the bogie being shaped like an inverted double-

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ended boat, to facilitate its passage through the water, and also to remove any obstructions from the rails. The four bogies are firmly held together by steel tubular struts. The wheel base, about 28ft. long and the effective gauge 18ft., round and forms a promenade deck, seats being placed over the glass dome and over the centre of the saloon. On this upper deck will be placed the controlling apparatus for driving and stopping the car. As the journey, in short,

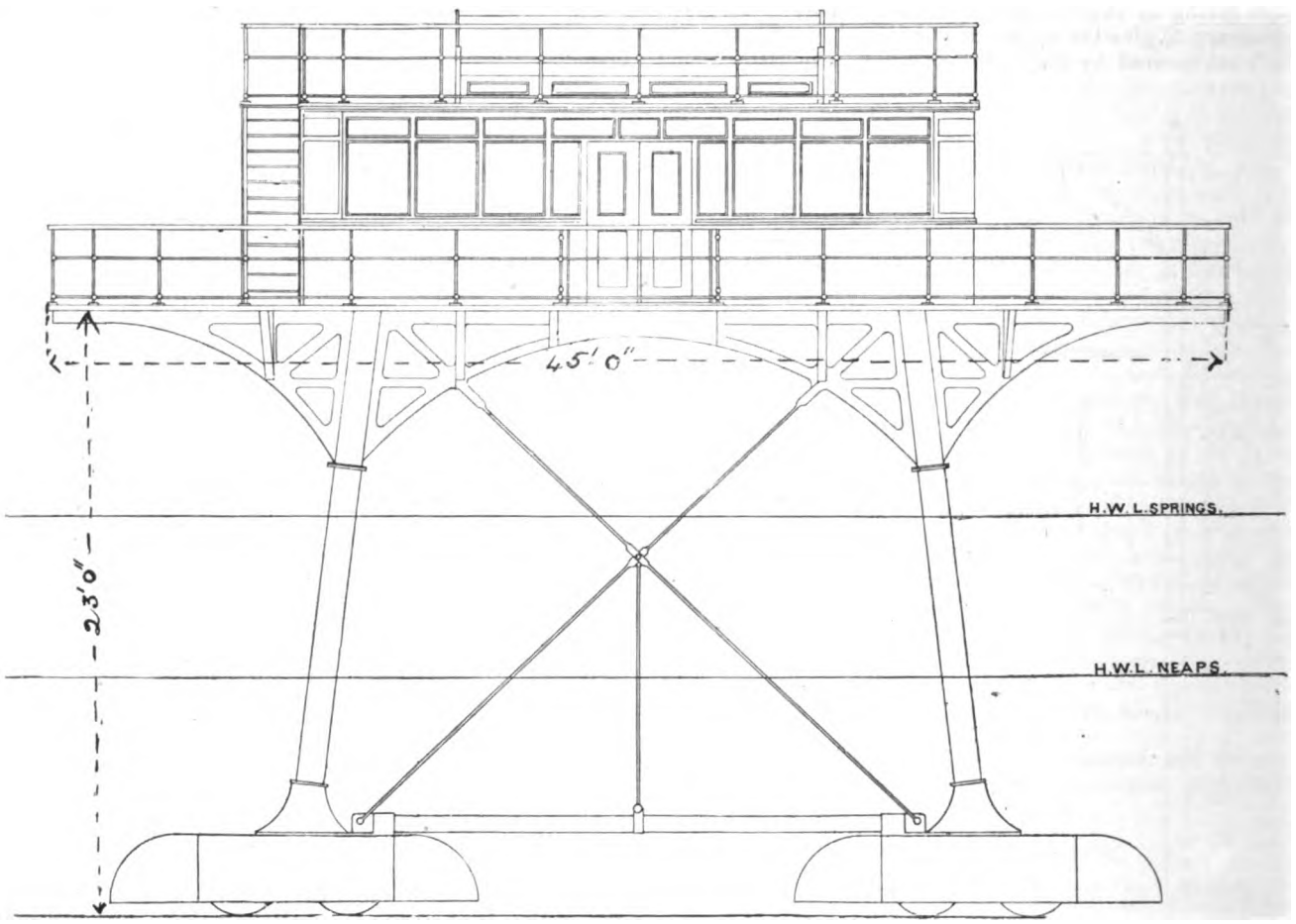

FIG. 2.—Side Elevation of Car.

give great stability to the car. The top of the main legs are firmly built into lattice girder work carrying the deck, and the whole structure is firmly secured by cross-ties. It is of great strength, although offering but a small surface to the force of the waves. The main deck appurtenances and erections will be undertaken more for the sea air than for quickly making the trip, it is proposed to keep the speed between six and eight miles an hour.

The driving machinery will consist of two 30-h.p. electric motors placed vertically over two of the main legs, one on

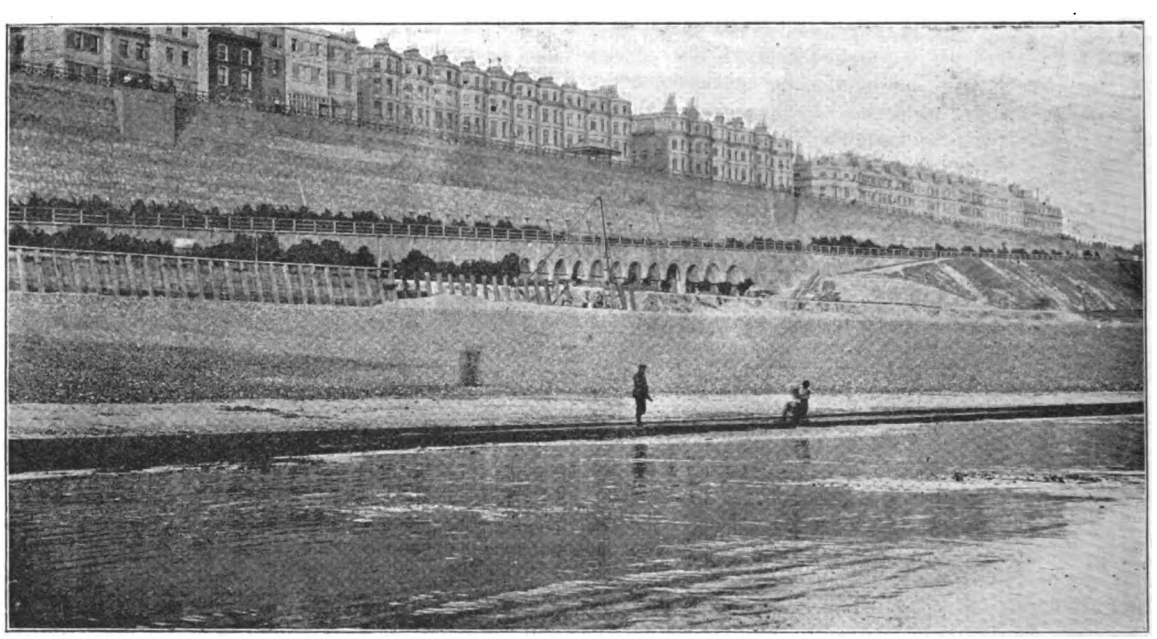

FIG. 3.—View of Track within the Corporation's Boundary.

are carried out exactly as if for a steam yacht. The deck measures 50ft. by 22ft., the railings round the deck being of iron with a wooden top rail and wire netting. The centre space of the deck is occupied by the saloon, a structure 12ft. wide by 25ft. long. The roof of the saloon is railed each side of the car, the shafting being carried down inside and communicating with toothed gearing which actuates the wheels. The brakes are worked by rods passing down the remaining two legs. The current, at 500 volts, will be conveyed to the car by means of a trolley pole and overhead

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wire, provided the consent of the Corporation of Brighton be obtained for the portion within the borough.

Fig. 3 shows a view of the track and foreshore within the borough boundary, from which the reader can gather an idea of the surroundings, which certainly will not be prejudicially affected by the erection of ornamental poles 80 yards apart.

At the meeting of the Brighton Council on November 1 various reports concerning this tramway were considered. Those of the borough engineer (Mr. May) and the borough electrical engineer (Mr. Wright) arise out of the application of the company for permission to carry their wires on poles. The Works Committee had written to the Board of Trade calling attention to the matter, and enquiring whether the Board had required the car to be so increased in strength as to make the weight of the car quite double what was originally contemplated, the company alleging that this extra weight necessitated the use of the poles. The reply came in the form of a copy of a letter which had been addressed by the Board to the company in the matter. In this letter the company were asked: 1. What is the weight of the car as now being constructed? 2. In what manner, and at whose request, the design of the car has been altered so as to increase its weight? And 3. The number of passengers to be carried (*a*) in the original pattern car, (*b*) in the pattern now proposed?

The Works Committee also instructed the surveyor and the electrical engineer to draw up reports on the subject, and the documents are appended, the first being from Mr. MAY, the borough surveyor:

"In obedience to your command to place before you all the facts relating to the construction of this tramroad, I beg to say that when the promoters first submitted for your consideration the Bill by which they proposed to seek for parliamentary powers to construct their tramroad, and the plans which are always deposited with such Bills, your committee were distinctly informed: 1. That there would only be two lines of rails, about 26ft apart. 2. That these rails would only project 4in. above the surface of the chalk, or sand, forming the foreshore or beach. 3. That the line would not interfere in the least degree with the construction of any new groynes, as it could easily be carried over any such groyne, or round the south end of it at any point. 4. That the car would be of light construction. 5. That the car would be easily driven by electricity from accumulators carried on the car.

"If these arrangements had been adhered to there would have been: (*a*) Practically no risk to bathers or boats (*b*) The groyne at Black Rock would have been constructed as originally designed and approved by the Town Council solely as the best method of protecting the eastern foreshore. (*c*) There would have been no obstruction to the free use of the sea, nor anything visible above the water.

"The original proposals have been departed from in the following particulars: (1) There are four lines of rails about 18ft wide between the outside rails. (2) Without having first obtained the sanction of the Town Council, the minimum projection of the rails above the chalk has been raised from 4in. to 18in., and rises from this to 2ft 3in. at Paston-place groyne; but the consent of the Council has been obtained on the recommendation of your committee to raise the line to 3ft. above the chalk at Black Rock groyne (3) By the special request of the company, and on the recommendation of your committee, the Town Council has agreed that the concrete groyne at Black Rock shall be reduced from 7ft 6in to 3ft. solely for the accommodation of the company, to enable them to carry their line over the groyne, instead of constructing it in low water beyond the south end of the groyne (4) The car and the gantry on which it is carried, as it is now being constructed, is designed to carry 150 persons, and is estimated to weigh when finished upwards of 40 tons exclusive of the weight of the motors and driving gear, and of the weight of the passengers The total weight of the car and passengers will therefore probably be little short of 60 tons. (5) It is the intention of the company to abandon the use of accumulators and to drive the car by overhead wires carried on poles, a method known as the 'trolley system,' if the Council will give their assent to the proposal.

'The effects of these deviations from the original proposals are: (*a*) The lateral obstruction caused by the rails is doubled (*b*) The additional height of the rails is likely to be a source of danger to bathers and to boats when hidden from view by shallow water only. (*c*) The reduction of the height of the groyne at Black Rock as originally designed, although perhaps unimportant at the present time, may in future years seriously detract from its usefulness. (*d*) The increased weight of the car and its gantry will make it of such unwieldly and ponderous proportions that it will have a very different appearance to that of the little elegant toy car at first proposed to be used by the company, and of which a model was submitted to you. You will gather some idea of the proposed car if you will realise that it will be equal to the weight of five or six steam road-rollers or of an ordinary railway steam locomotive. (*e*) The proposed poles and overhead cables are likely to be an obstruction to the sailing craft at high water in rough weather and at night, owing to the poles and wires being invisible.

"With regard to the application of the company for your permission to erect within the borough 13 cast-iron poles 21ft. above the high-water line, with arms 4ft. long, to carry two lines of cable, or overhead wires, for the purpose of driving the car by what is known as the 'trolley system,' you instructed me to confer with the Corporation electrical engineer, and to call in other expert assistance if we required it, to consider whether the overhead wire system is the only one that can be adopted by the company. I beg to say that we have conferred together as directed, and your electrical engineer will send in his special report upon the subject of electric traction and its method of application; also as to the practicability of adopting a motive power other than electricity in order to avoid the use of overhead wires; therefore, I need not refer to that part of the subject.

"It is, however, within my province to report to you that in considering the subject from a broad or general engineering point of view, it was necessary that we should be supplied with further information respecting the scheme than that which had already been furnished. I therefore put the following questions in writing to the engineer of the company, but I have not yet received any written replies thereto: 1. What is the weight of the proposed car? 2. At what speed will it be driven? 3 What is the maximum horse-power required to drive it at any part of the line at the time of high tide? 4. On what data is this power estimated? 5. Send a detailed drawing of the car with the motors and trolley attached.

"The company's engineer and their electrical engineer, however, afterwards called together to see your electrical engineer and myself. They courteously offered to give us all the information they could, and we elicited from them at the interview that it was impossible for them to give us definite information in reply to the questions I had put to them, because, as the project is entirely a new departure in engineering, there is no known data or formula on which they could base their calculations. They assured us they had done their best to arrive at correct conclusions from their own experience, and such other information they possessed as could be applied; but at the same time, frankly confessed that their conclusions are, to a great extent, problematical, and that it is by experience only, after actual experiments made on the line, that more reliable information can be obtained or given.

"I quite believe this to be the true state of the case, and in view of the facts that the company have found it necessary to depart entirely from the first arrangements—that they have no reliable knowledge that the present proposals are workable—that they need knowledge which can be gained only by actual experiments—that your electrical engineer is of opinion that a motive power other than electricity may, in practice, be found better and cheaper than electricity—and having been informed by the company's engineers that neither the engines, dynamos poles, or wires have yet been ordered, I recommend your committee to endeavour to make an arrangement with the company for them to complete so much of their line as is outside the borough, and to make their experiments thereon. This line is two miles two furlongs two chains in length and, therefore, affords sufficient scope for the purpose. The line within the borough is only four furlongs eight chains in length and could be easily finished when the company had ascertained all the necessary particulars for working it successfully. These experiments and their results would afford your committee and the public an opportunity of forming a correct opinion as to whether the project is likely to be beneficial or prejudicial to the interests of Brighton."

The following is the report of the electrical engineer, Mr. ARTHUR WRIGHT:

"As requested by your committee, the borough surveyor and myself have carefully considered the new proposal of the Rottingdean Tramway Company for driving their car, and we agreed that it would be well for us to put our views in the form of two separate reports. I therefore beg to state that, judging as best I can from the unfortunately very scanty information obtainable from the engineers of the company as to the horse-power required by a car running under such novel and difficult conditions, I am of opinion that, as steam power is considered by the Corporation to be inadvisable, the only two remaining systems known to me by which there is any probability that such a line could be worked so as to be a mechanical and, possibly, a commercial success are:

"First, the ordinary trolley overhead wire electric traction system, as used in America, Bristol, and other places. This method, although it involves the use of overhead wires, has the advantage of great flexibility, in that an almost unlimited amount of power can be conveyed to the motors on the car. I consider this, under the circumstances, a great advantage, as it appears that only the most hazy ideas are obtainable as to the horse-power required to drive the tramcar through the water at anything like a reasonable speed. Other advantages are that the trolley system has been well tried and worked out, and is very cheap to instal.

"Second, the compressed gas-motor system, as about to be used at Blackpool and in use on the Continent, in which the necessary gas is carried in tubes under the car in a compressed state. This method has the great advantage over the first of being practically self-contained. Theoretically, it certainly ought to be cheaper in initial cost and maintenance than the other system, and considering the particular line of route I am not aware of any feature which would render it unsuitable for the tramway in question.

"In my opinion it is quite possible to drive the car by the ordinary electric accumulators, but I consider this system to be unsuitable by reason of its much greater expense, both initial and maintenance, than either of the other two systems, and I do not

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consider that any combination of the electric accumulator and trolley systems could be satisfactorily worked in practice, as there are serious technical difficulties involved in the suggestion of working the car by accumulators while in the Brighton borough, and the trolley system when beyond it.

"Owing to the impossibility of ascertaining the horse power required to drive the car with its full complement of passengers, as neither the weight to be moved nor the amount of resistance due to wind and water or other friction appear to have been ascertained, and as no drawings have been submitted to me showing the proposed method of driving the wheels from the motors, I am quite unable to express a more definite opinion as to the practicability of the project beyond stating that I think it would be quite as possible to drive the car by compressed gas as by the overhead-wire trolley system, especially as I understand it is only intended to run one or at the most two cars."

The committee reported that they had also received communications from Sir Albert Sassoon and Colonel Wilson stating that they had no objection to the carrying out of the proposal, and from Mr. Mellor, on behalf of the Kemp Town Enclosure Committee, objecting to the erection of the poles.

The committee submitted the application of the company for the decision of the Council.

The following was forwarded to the town clerk, being the engineer's reply to the above reports:

17, Victoria-street, Westminster, S.W.
October 29, 1895.

The Chairman and Directors, Brighton and Rottingdean Seashore Electric Tramroad, Brighton:

Gentlemen,—In accordance with your instructions, I herewith beg to report on the subject-matter of the report of the Works Committee to the Town Council as follows: With reference to the gauge of the rails being altered from 24ft. to 18ft., and the number of lines of rails being increased from two to four, I beg to point that these alterations were sanctioned by the Corporation prior to the commencement of the work. The alteration in the level of the rails was rendered necessary by the height of the sand while the works were being carried out. The borough engineer stated to the Works Committee on their visit to our works that, judged from an engineer's point of view, he did not consider the rails had been laid one inch higher than was necessary to enable the line to be worked. I beg to enclose with this report two drawings to the same scale—A being the "model car" referred to by the borough engineer, and B the car as now being constructed.

I beg further to report that on the 15th inst. I received a letter from Mr. May asking for certain information as regards the car, and in order to save time I went to Brighton on the 15th inst, saw Mr. May and Mr. Wright early on the 16th inst, and gave them the following replies to their questions:

Question.—What is the weight of the proposed car? *Answer.*—The weight of the structure would be about 40 tons, and the weight of the electric machinery and people would bring it up to from 55 to 60 tons.

Question.—At what speed would it be driven? *Answer.*—We expected that the power we proposed putting on board would enable us to travel at an average speed of six miles per hour.

Question.—What is the maximum horse-power required to drive it at any part of the line at the time of high tide? *Answer.*—That we proposed putting two 30-h.p. motors on the car, which in our opinion would suffice.

Question.—On what data is this power estimated? *Answer.*—On the resistance (1) due to traction on the level, (2) due to the greatest incline, (3) due to the curve, (4) due to the wind, (5) due to the water, (6) due to the skin friction.

Copies of the drawing sanctioned by the Board of Trade were handed to them the same day. Pending the settlement of the question now before the Corporation, detail drawings of the electrical arrangement have not as yet been made, so I was unable to supply them with these, but at the same time explained that the trolley pole would be as sanctioned by the Board of Trade for the Bristol tramways. I did not understand from Mr. May that he wished me to repeat this information in writing. I cannot understand what experiments Mr. May desires should be made outside the borough boundary, and what object would be gained by the stoppage of the works within the same. In reference to this, I must point out to you that owing to the short time the work within the borough boundary is uncovered by the tide, we have only been able to complete 50 yards of the line between September 5 and October 21, so that any further stoppage of this portion of the works would render it impossible to complete the same within the time allowed by the Act of Parliament, which expires in July next.

The only point which now remains to be determined is, what speed will the car travel at with a certain amount of power? The great flexibility of the overhead wire system (as stated by Mr. Wright, the electrical engineer to the Corporation), in that an almost unlimited amount of power can be conveyed to the cars, coupled with the following facts: (*a*) the system has been well tried and worked; (*b*) the large range of power that can be obtained from electric motors; (*c*) that the motors can easily be changed, are the reasons which had led the advisers to the company to adopt this system, thereby ensuring that there will be sufficient power available to drive the car at a satisfactory speed.

With reference to Mr. Wright's (the electrical engineer to the Corporation) suggestion as to the adoption of gas-engines—this method of driving was carefully considered, prior to applying to the Corporation on May 14 for permission to temporarily use steam, and was abandoned for the following amongst other reasons: (1) No gas engines for traction purposes have been made approaching the power required. (2) The vibration in the compressed gas-motor cars to which Mr. Wright refers, although the motors are close to the ground, is considerable, therefore it is evident that if motors 10 times the power of these were placed on our high car, the vibration would be so excessive that passengers would not travel on it. (3) The objectionable smell and noise. (4) Serious mechanical difficulties in reversing and starting in the case of large powers, and where the inertia of our large car would have to be overcome. (5) The manufacturers, although willing to make an engine of sufficient power, would not, on account of the above-mentioned difficulties, undertake any liability as to the effective working of the arrangement.—Yours obediently,

R. St. Geo. Moore, Engineer to the Company.

The following notes, also, are the company's commentary upon the surveyor's report:

(2) This was an impossible condition imposed in the Corporation protection clauses owing to the undulating surface of the chalk and the shifting sand and was not in our original Bill at all. (*a*) The line as constructed does not cause any additional risk either to bathers or boats. (*b*) The following letters will show the site of the line was moved to allow the new groyne as originally designed to be constructed, and the line as now laid is 100ft. from the timber groyne, and that it was an amended proposal, of which we had no notification for 12 months afterwards, that caused all the difficulty. (*c*) The poles would be a distinct advantage as indicating the position of the line.

(1) The total width of the line is now only about 16ft. instead of 24ft., as originally intended.

(2) The words "or sand," which are in our Act, have been omitted after the word "chalk." The line was laid to conform to these conditions as far as possible, but the sand was withdrawn by gales when the surveyor measured the work; since then on two occasions the rails have been covered with sand. A photo showing the sand level with the rails will, if possible, be in the Council-chamber. (*a*) The rails being at one level the lateral obstruction is the same whether two, four, six, or any other number be laid. (*e*) With regard to this matter, the wires would be erected high enough to clear all small sailing craft. The submerged ends of the groynes, which project considerably further to sea than the line of rails, would cause all vessels to keep a course far outside them, whilst in stormy weather, when the whole shore is covered with breakers, a vessel getting within their influence would be wrecked any way, and the poles and wire would offer no obstruction to her coming ashore; and as at such times no current would be in the wire, no inconvenience could arise from this cause.

The following report of the Council's proceedings is from the *Sussex Daily News* of November 1:

Alderman Brigden moved that the report of the Works Committee on the application of the Brighton and Rottingdean Seashore Electric Tramway for leave to erect steel poles on the foreshore from Paston-place eastward be entered on the minutes. The committee, he pointed out, made no recommendation, but left the matter entirely in the hands of the Council. He wished the Council, however, to understand that the committee to a man had no hostility to the electric railway. It was a unique and novel venture, and they were all desirous of seeing it carried out satisfactorily.

The motion was put and carried.

Councillor E. A Dell: I move the adoption of the report.

The **Town Clerk**: There is no recommendation to adopt.

Councillor E. A. Dell: None whatever?

The **Town Clerk**: The committee have left it to the Council either to grant the request or not. It was now for any member of the Council to move a resolution.

Councillor E. A. Dell: I move that the report be acted upon. Well, I move that the request of the petitioners be granted.

Councillor Daniel: Which petitioners?

Councillor E. A. Dell: If you don't know, go to Rottingdean.

Councillor Booth, remarking that he had now entered on his anniversary of 25 years' service, said he would esteem it a great privilege if Councillor Dell would permit him to move a resolution.

Councillor Dell: Certainly; very pleased to see you returned to the Council without opposition.

Councillor Booth moved the following resolution: "That the application of the Brighton and Rottingdean Seashore Electric Tramway Company, dated September 23, for permission to erect 13 tubular steel poles, 80 yards apart, on the foreshore between Paston-place jetty and the borough boundary at Black Rock, for the purpose of carrying the electric trolley line, be, and is hereby, granted, provided that the company pay a rental of £1 per annum, and enter into a covenant to remove the poles on receiving three months' notice." He contended that the railway would be of the utmost benefit to the town, and would bring people to Brighton from the ends of the earth. (A **Member**: There are no ends of the earth.) Only a sixth of the whole line was within the jurisdiction of the Council, and he maintained that as the Board of Trade had more knowledge and greater responsibility in the matter than the Council, they would have been the first to raise objections if there had been any of a substantial character. As to the changes that had been made in the plans, he contended that they were essential in any invention. There was no comparison between the gas first introduced and the gas of the present time, and the same thing applied to the steam.

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engine or the electric light. He urged that the Council should assist those who were making this courageous venture to secure its success, and warned members that if this resolution were rejected there would be no electric marine railway for two or three years.

Councillor Titcomb seconded the motion.

Alderman Abbey urged that the present scheme was a complete departure on the part of the railway company from the old scheme that was partially assented to by the Town Council. It embraced all the objectionable parts of the whole scheme, and now were added these poles and the overhead wires, the result of which would be that the inhabitants of Brighton would be deprived of a quarter of their foreshore. The foreshore of Brighton was nearly 4,000 yards in length, and it was proposed to destroy the use of it for about 1,000 yards. In granting this the Council should have some guarantee, some security in the way of a deposit, that in the event of the railway not being carried out the *débris* would not be left, probably for years, as a monument of their foolhardiness His amendment was that the application be granted conditionally on £1,000 being deposited as a security for the whole of the *débris* being cleared away if the railway did not answer, and that the whole matter be referred to the Works Committee to carry out.

Councillor Willett said he would second that.

After some little delay, **Alderman Abbey** put his amendment in this form: "That the motion be amended by adding the following words: Provided that the sum of £1,000 is deposited by the company with the Corporation by way of security for the removal of the tramway in the event of its being abandoned at any time hereafter, and that the details as to the application of such security be embodied in an agreement to be approved by the Works Committee."

Councillor Willett refused to second the amendment in this form, but **Councillor Wishart** said he would do so, as he thought this would be a sufficient safeguard of the interests of the town.

Councillor Daniel said they all knew Councillor Booth was very considerably interested in this matter. He was not speaking financially, and he might say that he was himself equal interested in it—for the good of the town. But Councillor Booth entirely ignored the fact that the surveyor had, at the request of the committee, reported on this application, and had practically told them point-blank that they would be doing a very foolish thing if they granted this application. Unless the Council got a more efficient control over the foreshore than was proposed, they would be making a great mistake in the interests of the town and in the boating and fishing interests.

Councillor George pointed out that the Council had already granted the company the power to raise their line 3ft. above the proposed groyne. That might be a very great obstacle to the boating interest, but it had been done.

Councillor Sutton said he supported the application almost entirely on the two reports furnished by the Council's own officials. The reduction in the height of the groyne was a matter already settled by the Council; and, moreover he thought it unfair to press for the company being bound down to full details when the surveyor admitted in his report that it was at present impossible to give them. But in the report of their own electrical engineer the Council would find all the justification necessary for granting the application. Mr. Wright said the trolley system was the best means to work the line to ensure financial success.

Councillor Titcomb urged that there was guarantee enough in Councillor Booth's motion, coupled with the fact that the promoters were putting their capital in the undertaking.

Councillor Blaker said he was going to give one of the most painful votes that it had been his unhappy pleasure ever to record Conscience spoke louder than his admiration of Mr. Volk, and as an east-end member he would vote against Councillor Booth If those 13 poles had been in the original proposal it would never have been listened to, and he considered the present scheme a violation of the rights of the people.

Councillor Dutton Briant said he found in an inspired article on the railway that the sand had shifted very much since the commencement of the undertaking, from which one might fear alteration in the future that would seriously affect the railway. Then the lines, he understood, were placed on concrete blocks "morticed into the rock." But the only rock was chalk, and with the vibration of a 60 ton car going over them was there any likelihood of the concrete blocks being able to hold on? He was anxious to see the railway a success, but these objections, in his mind, would have to be removed before he could support the proposal at all.

Councillor Halliwell said the company had shown by their action that they were anxious to meet the Corporation and carry out any additional suggestions possible. He contended that Mr. Wright's report was strongly in favour of the company's application, and urged the Council not to do an injustice to a private company. Let them carry on the farce no longer, but pass the resolution Councillor Booth had moved.

Alderman Moon said that Mr. Wright, instead of recommending the trolley system, really recommended the gas motor system He reminded the Council that in the first instance the promoters said the car would be run by means of accumulators. This, it turned out, was not impossible, but would probably prevent the railway being a commercial success This was not the fault of the Council, nor of the Works Committee They naturally supposed that when gentlemen commenced an undertaking they counted the cost, and did not begin until they knew they could finish. It seemed to have dawned on the promoters in some way that the car, instead of a light thing, would have to be 40 tons in weight, or with passengers and motors 60 tons—about five times the weight of a road-roller, or about the weight of a locomotive. That was not the fault of the Council, nor the Works Committee. Then the company raised their rails from 14in. to 18in. without any notice to the Corporation, and now they asked for leave to erect thirteen steel pillars of a considerable height with brackets to carry a cable about ½in. in diameter, probably with suspending cables. It was not only a question of the danger to boating and bathing, but of how far this was going to interfere with the beautiful view. Alderman Lowther had suggested to him that it might be practicable to extend the present electrical line to the eastern boundary, so that the steel poles would not be necessary.

Councillor Titcomb: That belongs to another company.

Alderman Moon: That is not an insuperable difficulty. We are dealing with men of genius and resource.

Councillor Weston said he had always been an opponent of the electrical line on the front, because it took the beach away from the people. He thought the rent fixed should be at least £100.

Alderman Reeves suggested for the consideration of the Council whether, at a private meeting of the Council in about a fortnight's time, with the electrical engineer, the surveyor, and the engineer to the company present, they would not be able to arrive at a better understanding on the matter, and a more just conclusion than at present. Alderman Reeves afterwards explained, in reply to Councillor McClean, that the meeting need not necessarily be held *in camera* He meant a meeting of the Council held under the rules for committees.

After some hesitation, **Councillor Booth** accepted this proposition, and amendment and resolution were withdrawn by leave of the Council.

On the motion of **Alderman Reeves**, it was then formally decided that the debate be adjourned to a convenient time, about a fortnight after the election of the new Council, that the company be invited to send their engineer, and that the borough surveyor and electrical engineer attend.

LEGAL INTELLIGENCE.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY v. EBBSMITH.

On Monday, in the Court of Appeal, consisting of the Master of the Rolls and Lords Justices Lopes and Kay, Sir F. Lockwood, Q.C (with whom was Mr. Scrutton) appealed from an order of Mr. Justice Hawkins refusing the plaintiffs leave to inspect the books and take copies of the banking accounts of the defendant (Mr. Ebbsmith) and of the Dickinson Tramway Appliance Company at the branch office of the Metropolitan Bank of England and Wales, and to inspect as well the books of the Staffordshire Joint-Stock Bank and their successors for the years 1885 to 1894. The plaintiffs were bringing an action against the defendant Joseph Ebbsmith and William James Carruthers Wain for the rescission of certain contracts for the purchase of the patents and certain land at Wednesbury, and the return of the money paid for the same, with interest at the rate of 5 per cent.

Lord Justice Kay said it was a strong step to ask for leave to inspect the banking account of the Dickinson Company, as well as the banking account of Mr. Ebbsmith, the defendant in this action.

Sir F. Lockwood said that Ebbsmith and the Dickinson Tramway Appliance Company were one and the same. The plaintiff company was brought into existence in 1889. It took over the property and rights of the South Staffordshire and Birmingham and District Steam Tramways Company, of which the defendant was a promoter, and was from March, 1887, until April. 1889, local solicitor of that company, and from the latter date he was its parliamentary solicitor. Both defendants are promoters of the plaintiffs, and as such they are in a fiduciary position to the limited company and the plaintiffs. They had, as the plaintiffs alleged, made "secret profits."

The **Master of the Rolls**: And you want to inspect the bank books to get evidence against them?

Sir F. Lockwood: Yes; we say that the defendant Ebbsmith sold us patents which were worthless, and land that was unnecessary at Wednesbury, and if inspection of the bank books be granted we can show that Ebbsmith—whose name was formerly Smith—was in fact the Dickinson Appliance Company, and that the money we paid to that company went to his account. He owned 1,500 out of the 1,507 shares in the company, the other shares being held by his clerks

The **Master of the Rolls**: It is an unusual request to make.

Sir F. Lockwood said that the office of the Dickinson Appliance Company was the office of Ebbsmith, who had been solicitor to the South Staffordshire and Birmingham and District Steam Tramways Company. We produced affidavits before Master Butler when he made the order for the inspection of the bankers' books at Wednesbury. The cashier of the Dickinson Appliance Company was Mr. Ebbsmith's own clerk, and, in a word, it seemed that he was the Dickinson Company himself.

The **Master of the Rolls**: We have had a good deal of experience during the last six months in this little game.

Sir F. Lockwood: Unfortunately it is not a little game; it is a big game. He gets a patent for next to nothing and sells it to the Dickinson Company for £5,000.

Lord Justice Kay said that Sir F. Lockwood had not given any proof of the statements that he had made—that Ebbsmith was the Dickinson Company.

Sir F. Lockwood said that Ebbsmith sold three acres of land for £1,000 to the Dickinson Company, and the plaintiffs alleged that this land was not necessary for the purposes of their under-

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taking. In fact, the plaintiffs alleged that the Dickinson Company was Ebbsmith's own company.

Mr. Loehnis said he was there to represent the Dickinson Company, which was quite apart from Mr. Ebbsmith.

Mr. Bower said he appeared for Mr. Ebbsmith alone, and he was there to oppose the application.

The **Master of the Rolls** said he thought Sir F. Lockwood ought to be allowed to support his statements by affidavits.

Mr. Bower asked for the dismissal of the appeal, as against Mr. Ebbsmith, with costs.

The **Master of the Rolls**: We refuse to do that. We postpone this appeal until next week, and all other questions with regard to it.

Mr. Bower: I think we ought to have our costs of the postponement.

The **Master of the Rolls**: The question of costs, also, is postponed.

ROTTINGDEAN ELECTRIC LIGHT WORKS.

In the Chancery Division of the High Court of Justice on November 1, before Mr. Justice Kekewich, **Mr. Renshaw, Q.C.**, said that he had a motion in an action in which Sir E Burne-Jones, who was the plaintiff, moved for an injunction to restrain the defendants—the New and Mayne Company—from working electrical machinery at Rottingdean in such a manner as to cause a nuisance to the plaintiff by noise, vibration, and smoke. The defendants had submitted to a perpetual injunction and to pay the costs. Operation of the injunction was ordered to be suspended so as to enable the company to carry out alterations to abate the nuisances complained of.

COMPANIES' MEETINGS AND REPORTS.

ELMORE'S COPPER DEPOSITING COMPANY, LIMITED.

The annual meeting of this Company was held at the Great Northern Hotel, Leeds, on November 1, Mr. John North (chairman) presiding.

The **Chairman**, in moving the adoption of the report, which appeared in our last issue, observed that the directors had been in office rather less than 12 months. Although they had not had at their disposal any other resources than those possessed by their predecessors, and notwithstanding that during the past year there had been a drop in the average price of their finished manufactures of over £12 per ton, they had been able to wipe out the old sources of loss which were so serious in the two preceding years, and to effect an actual net profit of £480. 6s. 4d.—a profit which was even rather better than it looked upon paper. They had also had, as previously, to contend with determined competition, and the year had had to bear the burden of one or two low-priced contracts, which had not been executed at the time they took office. Explaining this improvement, he said that, in the first place, there had been a much larger turnover in the factory without any corresponding increase in the expenses, and next they had effected considerable economies, and further, the Messrs. Elmore had, if possible, exceeded their former efforts in striving to lift the Company out of its former difficulties. If they had been working all this year to their full capacity they should have presented a very different account. As to the profit, he entered into a number of financial details, and said that there was really a net profit of £1,236 on the proper basis of the Company's manufacturing operations. They had reached a point when it was practically impossible to do better than they had during the last six months unless the Company was furnished with adequate capital. The Company had no difficulty in securing very remunerative orders, and they expected to be appointed on the list of contractors approved by the Admiralty, which would enormously increase the amount of business offered to them. They had already supplied tubes and cylinders to foreign navies, though they had not yet been directly appointed contractors to the British Navy. The comments passed upon the copper condenser cylinders made for Russian boats built by Mr. Yarrow by competent engineers were very gratifying, and it was well to remember that these large cylinders could only be produced by the Company's process. With regard to the method of raising further capital, it was proposed to extend the Company's borrowing powers, as such a step would give them every power and facility that could be afforded by an increase in the share capital of the Company, while it had the advantage of saving the expense of increasing the share capital, and possessed other advantages. They already had some substantial offers of assistance in the debenture issue, but in the first place the offer would be made to the shareholders, and the directors hoped they would respond now that the Company had been brought through its difficulties and established upon a paying basis. With regard to the proposed reduction in the ordinary share capital, he thought it must be evident to all of them that that step was necessary, and that at the same time it inflicted no injury or loss upon anyone. The Company's profits would be exactly the same whether the capital was reduced or not, and the dividend upon the reduced share would, of course, be double the rate of the dividend paid upon the full amount of the share, so that the market price of the reduced share must respond to the dividend in either case. The chief advantage of the reduction would be that it wiped out the old loss and enabled them to divide at once any profits as they were made. It might be well, perhaps, if he explained the meaning of the resolution to be submitted to the preference shareholders. The terms upon which the preference shares were created were that they received a preferential 10 per cent. dividend, and then the ordinaries took 10 per cent., and the balance, if any, was divided *pari passu* amongst the preference and ordinary shares together. In practice, this meant—provided the profits were sufficiently large—that the preference and ordinary shareholders would always receive exactly the same dividend upon their shares, but this equality of dividend would at once be upset if the ordinary share capital was reduced by 50 per cent., and unless the preference shareholders passed the resolution to which he referred the ordinary shareholders in future would only receive half as much as they would have received if the capital had not been reduced. They, of course, were not asking the preference shareholders to give up anything whatever of their rights; they were only asking that they would not take more than they were now entitled to. In future the practice would be to give the preference shares a preferential 10 per cent., and then 20 per cent. to the ordinary shareholders on the reduced capital, and the balance (if any) would be divided in the proportion of about 91 per cent. to the ordinaries and 9 per cent. to the preference.

Several shareholders, while recognising the good work accomplished by the present Board, offered a mild criticism to some of the features of the report, and one of the speakers concluded with an amendment in favour of a committee of inspection. The amendment, however, only found four supporters, and the original resolution was adopted, with the suggestion, accepted by the chairman, that the directors be authorised to write off £11,012 standing to the credit, and the reducing the assets to that extent.

Mr. John Marshall was re-elected on the directorate, and Messrs. H W. and J. Blackburn were reappointed accountants.

The **Chairman**: Mr. Marshall and your directors urged upon the shareholders to assist them in raising the required additional capital. If they could raise £30,000 it would mean a largely increased business.

Special meetings were afterwards held, and resolutions adopted in favour of raising the additional capital.

WOODHOUSE AND RAWSON UNITED.

A meeting of the debenture-holders of this Company was held on Tuesday last at Cannon-street Hotel, E.C., Mr. C. J. Stewart (the official receiver) presiding.

The **Chairman** said that the meeting had been called in consequence of an order of the Court. At a meeting on June 13 last it was decided by a majority of those present that the debenture-holders were averse to the funds realised in the debenture action being appropriated for the purpose of taking proceedings against the directors, auditors, and officers of the Company under Section 10 of the Act Following on the public examination, a case was prepared by the solicitors who were acting for the official receiver and liquidator, which was submitted to the solicitors representing the receiver, and the case was approved by them, and was submitted to counsel, who gave it as his opinion that proceedings would be successful with respect to dividends paid by the Company during certain years. The matter came before Mr. Justice Vaughan Williams, who had directed that meetings of the debenture-holders should be held for the purpose of obtaining the votes of the debenture holders for or against taking proceedings against the directors and auditors. If the majority, who were averse to taking proceedings, were to abandon their claim, it would leave it open for those creditors standing after them to find the money for proceeding, and take the profit of whatever might be recovered. The votes, therefore, would be taken separately of the 5½ and 6 per cent. debenture-holders as to taking proceedings or not, and in the event of not taking proceedings of abandoning or giving up their claim.

Some conversation took place as to the exact effect of the voting papers the debenture-holders were asked to sign and hand in, and the **Chairman** stated that would report the result to the Court.

THE VICTORIA ELECTRIC RAILWAY AND LIGHTING COMPANY, LIMITED.

A meeting of the debenture-holders of this Company was held on Wednesday at 8, Austin-friars, Mr. R. M. Horne-Payne presiding.

The **Chairman**, after stating that £1,000 of bonds had that morning been drawn for redemption at 105 per cent., remarked that immediately after the results of last year's working became known the trustees, in accordance with the powers vested in them, paid away £43,000 in respect of liabilities. It afterwards came to the knowledge of the trustees that there existed further liabilities of between £8,000 and £10,000. As these had not been disclosed in the directors' schedule they declined to recognise them, and this action on their part brought the Company to a deadlock. One of the creditors then applied to the Court for the appointment of a receiver, and his application was granted, with the distinct understanding that every penny of earnings should be held in trust for their bonds, and that all mortgages and encumbrances should be protected. The Court at the same time admitted that the debenture-holders had the right, if they desired to exercise it, to enter into possession of the property. In these circumstances, it became the duty of the trustees to consider how they could best secure the interests of the debenture-holders, and, as a result, preliminary negotiations had been entered into with the Consolidated Railway of British Columbia to work the line, and to guarantee their bonds in

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consideration of receiving the surplus profits of the Victoria Company. The Consolidated Company's bonds bore interest at the rate of 4½ per cent., and they would consequently only guarantee the bonds of the Victoria Company up to the same amount. It was proposed in order to make the interest up to 5 per cent., that the holders of Victoria bonds should receive for each £100 one-quarter of 100dol. fully-paid ordinary share of the Consolidated Company. If some such arrangement was come to the debenture-holders would avoid the trouble and risk of themselves working the line, and their security would be, if anything, rather better than before.

On the motion of **Mr. Sperling**, seconded by **Mr. Sidney White**, the trustees and directors were authorised to carry out and complete the negotiations on these lines, and it was stated that the chairman would at once go out to Canada with that object. It also appeared that, in spite of the receivership, the receipts of the railway during the last year showed an increase of more than 10 per cent.

OSWESTRY ELECTRIC LIGHTING AND POWER COMPANY, LIMITED.

A special meeting of the shareholders of this Company was recently held at the Harlech Castle, Oswestry, when there were present Messrs. A. Wynne Corrie (chairman), E. Bremner Smith (managing director), and Robert Lloyd and George Perks (directors).

The **Chairman** said he considered the report the directors had to make was very satisfactory. They were selling between two-thirds and three-fourths of one unit, but the Board of Trade required them to raise £500 of capital, and they meant to send round to the present shareholders so as to give them the first chance of taking more shares, and after they had received replies from them they would invite the public to take shares. It seemed to him that those who had already taken shares might like to increase their number, and that as they had backed up the Company originally they might feel that they should be given the first chance now the Company promised to be flourishing.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

The report of this Company for the June half-year, to be presented at the thirtieth ordinary general meeting in London on Thursday next, states that the total earnings amounted to £84,937, as against £77,603, an increase of £7,334 compared with the corresponding period of 1894. The working expenses came to £37,891, as against £37,953, a decrease of £62. Including £2,846, the amount brought forward, the balance to the credit of the revenue account is £49,891, from which has to be deducted £11,223 for debenture interest, £7,877 for the debenture redemption fund, £1,730 for income tax, and £5,000 placed to the reserve fund. The directors now recommend the payment of a dividend at the rate of £2. 10s. per cent. per annum, as against £2 per cent. per annum for the corresponding period, carrying forward £5,803. This dividend will be payable 3s. 9d. per share to the ordinary and 3s. 9d. per share to the preferred ordinary shares The position of affairs between the Government of Brazil and the Company as to the acquisition of the cables remains the same as at the date of the last general meeting. The Government, however, are taking authority to continue the authorisation for the purchase of the Company's system. The shareholders are aware that the Amazon Telegraph Company, Limited, has recently been formed for the purpose of laying a system of cables up the River Amazon and connecting many important places on that river with Para, the northern terminus of this Company's system. The directors anticipate that when this line is opened, in or before March next, it will prove a valuable feeder to this Company. The directors have to notify that the conversion of ordinary shares into preferred ordinary and deferred ordinary shares will be suspended on and after January 1 until further notice.

WEST INDIA AND PANAMA TELEGRAPH COMPANY, LIMITED.

The report of this Company for the half-year ended June 30 states that the amount to the credit of revenue is £39,849, against £40,598 for the corresponding half-year, and the expenses have been £21,848, against £24,488, leaving a balance of £18,001, which, with £710 brought forward, makes a total of £18,711. A dividend on the ordinary shares of 1s. 3d. per share, tax free, is announced, leaving a balance of £1,421 to be carried forward.

THE ALUMINIUM COMPANY.

The report of the directors for the 12 months ended June 30 states that their forecast regarding the value of the new patents belonging to the Company has been realised, and that the general business of the Company at Oldbury continues satisfactory. The accounts show a gross profit of £16,901 for the financial year. After providing for debenture interest, amounting to £7,497, and other fixed charges, there remains a balance of £3,901, which, with the sum of £1,475 brought forward from last year, makes the sum of £5,376 available for distribution. Out of this the directors recommend the payment of a dividend of 5 per cent. for the year on the "A" shares, which will absorb £3,000, leaving a balance of £2,376 to be carried forward. The shareholders have been informed of the agreement entered into in January last with the Mathieson Alkali Company, of America, for the sale of the electrolytic alkali patents for the United States, and the directors have to report that the plant has been completed, and is now being put into operation. The Company are to receive upon the satisfactory running of the plant the sum of £65,000, payable as to £30,000 in cash and £35 000 in shares, besides substantial royalties calculated on the output, with a minimum sum guaranteed during the life of the patents. In October last an agreement was concluded with Messrs. Solvay et Cie., who are the owners of the Kellner alkali patents, for a combination of both the Castner and Kellner patents, for the mutual advantage of the Aluminium Company and Messrs. Solvay et Cie. The Aluminium Company, under this arrangement, obtained the sole right to work the combined patents in England and the Colonies, and Messrs. Solvay et Cie. the sole right to work the same patents on the Continent. The agreement also makes provision that both companies shall work in friendly alliance for at least 12 years, and the Aluminium Company receive a sum of £5,000 as an extra consideration for such agreement. This arrangement enabled the directors to sell the Castner patents with the benefits of the agreement with Messrs. Solvay et Cie. (other than the right to receive the said sum of £5,000) to the Castner-Kellner Alkali Company, Limited, for the sum of £125,000, payable as to £25,000 in cash and as to £100,000 in shares. Such intimation was given to the shareholders at the last meeting as to another important chemical process invented by Mr. Castner. So successful has this last process proved to be, that an arrangement has been concluded between this Company and one of the largest and most influential firms in Germany for the sale of the American patents, together with certain other manufacturing privileges. This Company will receive the sum of £10.000 (£5,000 of which has already been paid) and 30 per cent. of the share capital of the American company now being formed, the capital of which has been guaranteed by the German firm. This leaves the Continental and British patents still to be disposed of, and as negotiations are pending for their sale it is deemed advisable to make no further announcement. The directors consider that any depreciation on the patents and on the works at Oldbury is more than covered by the developments in respect of patents which stand on the books of the Company at comparatively nominal figures. It is decided to pay off the £12,000 10 per cent. "B" debentures which fall due on January 1, 1896. The directors are also making arrangements for reducing the present £6 per cent. debenture debt by paying off the present issue, and, if necessary, raising a much smaller loan at a lower rate of interest.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

New Windsor.—The Windsor Corporation invite proposals by January 1, 1896, for taking over and working their electric lighting order. For particulars see advertisement columns.

Saarbruck.—Tenders are invited by November 15 for the supply of 1,500 telegraph posts. Conditions, etc., for one mark from Die Eisenbahn-Telegrapheninspection, Saarbrücken, Germany.

Lisbon.—Tenders will be received up to November 13 for the supply of various spare electrical machinery, for the Portuguese Royal Railway Company. Conditions, etc., at Paris, rue de Châteaudun, 28

Brussels.—The Ministère de la Guerre invites tenders by January 15 for (1) a heating installation, (2) electric lighting in the new military school to be constructed in the Avenue de la Renaissance, Brussels.

Fermoy.—The Town Commissioners of Fermoy, co. Cork, invite tenders and schemes from electrical, manufacturing, and contracting companies for the lighting of the town of Fermoy (public and private) by electricity. For particulars see advertisement columns.

Kassel.—The Fulda Canalisation Direction invite tenders for the supply of six automatic water-level indicators, with electric alarms. Pneumatic apparatus preferred. Particulars from and tenders to Das Hauptbauamt der Fuldakanalisirung in Kassel, Lutherstrasse 5, II.

Punta Arenas (Chili).—Tenders will be received until December 5 for the manufacture and laying of a submarine telegraph cable from Puerto Montt to Punta Arenas. The conditions and specifications may be consulted in the Chilian Legation, Member's-mansions, 36, Victoria-street, S.W.

Cambridge.—Tenders are wanted for the supply of 1,000 tons of steam coal, for the Cambridge Electric Supply Company, Limited. Full particulars and conditions, with form of tender, may be obtained on application at the company's offices. Mr. John H. Barker, secretary, Thompson's-lane, Cambridge.

Madrid.—The Director of Public Works invites tenders by November 15 for the concession of the construction and working of a tramway from Madrid to Colmenar Viejo, with branches to Chamartin and Rosa. Security, 12,505 pesetas. Particulars at the Direccion General de Obras Publicas (Ministerio de Fomento), Madrid.

Vienna.—The Government Commissioner, who at present takes the place of the Mayor of Vienna, invites plans and tenders for the construction of an electric city railway there. A detailed list of the lines which have to be built is given. They are to be circular, and are to form radii from the centre of the city to each

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of the suburbs, including the Prater, the Kahlenberg, and the great cemetery at the Semmering. All offers and plans must be addressed to the Vienna Town Hall before November 14.

Blackburn.—The Corporation of Blackburn are prepared to receive tenders by November 30 for the following: Section (B)—steam alternators and motor alternator; Section (C)—switchboard and engine-room connections; Section (D)—street transformer-chambers, transformers, etc. For particulars see advertisement columns.

Huddersfield—Tenders are invited for the works required in erection of a mill, and include an engine-house, boiler-house, chimney, dynamo house, etc. The specifications may be obtained of Messrs. John Kirk and Sons, architects, Huddersfield and Dewsbury, from 14th to 28th inst., on which latter day sealed tenders are to be sent in to them.

Paris.—The Director Générale des Postes et des Télégraphes, rue de Grenelle 103, Paris, invites tenders by November 21 for the supply of 6,000 iron cross-pieces with galvanised accessories, 29,000 cross-pieces with accessories, 134,000 consoles, and 400,000 galvanised iron screws (eight lots). Requests for admission to the adjudication before November 11.

Derby.—The Corporation desire tenders for the wiring, fittings, etc., for the completed portion of the Derby Municipal Technical College, Green-hill, Derby. Specification and form of tender, containing plans, schedule of rooms, etc, may be had on deposit of £1 1s., which will be returned on receipt of a bona fide tender, from Mr. J. E. Stewart, engineer, Electric Lighting Station, Derby, on and after 4th inst. Tenders, endorsed "Wiring, etc, of College," to be sent to Mr. H. F. Gadsby, town clerk, Town Hall, Derby, by 12 noon on 12th inst.

Warrington.—The Cheshire Lines Committee, among other stores to be supplied in 1896, desire tenders for telegraph materials, instruments, and wire. Patterns can be seen and specifications, with forms of tender, obtained upon application to Mr. Saxon Barton, storekeeper, Cheshire Lines, Warrington, and intending contractors are requested to particularise the stores for which they wish to tender. Sealed tenders, endorsed "Tenders for ——," to be in the hands of Mr. Glegge Thomas, secretary, Central Station, Liverpool, addressed Cheshire Lines Stores Department, Warrington, by 10 a.m. on 30th inst.

London, S.E.—The Metropolitan Asylums Board desire tenders for the execution of wiring and other work in connection with the electric light installation at the Brook Hospital and Ambulance Station, Shooter's Hill, S E. Copies of the specification, form of tender, conditions of contract, and of the drawings which have been prepared by Prof. Kennedy, LL D, F R.S., 14, Old Queen-street, Westminster, can be obtained of Mr. T. Duncombe Mann, clerk, Norfolk House, Norfolk-street, Strand, W.C., on and after 4th inst., upon depositing gold or Bank of England notes to the value of £25, which will be returned only to those who send in a bona fide tender, and who return the drawings, specification, and conditions of contract Tenders which will only be received on the lithographed form supplied by the Board, must be sealed and endorsed "Tender for Wiring, etc.," Electric Light, Brook Hospital," and must be delivered at the offices of the Board by 11 a.m. on 18th inst. Unless the tender be accompanied by the specification, conditions of contract, and the drawings, it will not be considered.

RESULTS OF TENDERS.

Southwark (London).—The St. Saviour's Guardians have accepted the tender of Messrs. Morris and Son, at £59. 10s., for an installation of the electric light in the Board-room and offices.

Aberdeen.—For the electric light wiring of the Aberdeen Public Library, for the Library Committee (Mr. Alfred S. Blackman, city electrical engineer), the tender of Messrs. Shirras, Laing, and Co., Schoolhill, Aberdeen, has been accepted.

Bradford.—The Gas and Electricity Supply Committee will ask the Town Council to-morrow (Saturday) to ratify a resolution accepting the tender of Messrs. Holdsworth and Sons for the supply of a boiler for the chemical works for the sum of £273.

Dewsbury.—The tender of Mr. G. A. Steinthal, of 41, Piccadilly, Bradford, has been accepted for wiring the public baths and library for the Corporation. The following is a list of the tenders received:

G. A. Steinthal, Bradford	£284	0	0
A. R. Turner, Dewsbury	295	0	0
J. A. Edmondson, Leeds	307	1	6
Maunsell, Mercier, and Co., Manchester	346	14	0
A. Sykes, Huddersfield	392	0	0
Lomax, Kendal, and Co., Manchester	405	0	0
Paterson and Cooper, London	424	15	0
A. Hirst and Son, Dewsbury	424	16	0
Fowler, Lancaster, and Co., Birmingham	482	0	0
Northern Counties Electrical Construction Company, Manchester	641	0	0
Howe Electrical Engineering Company, Liverpool	895	0	0

The inclusive cost of the work was estimated by Mr. John B. Mitchell, the borough electrical engineer, to be £393.

City and South London Railway.—The returns for the week ended November 3 were £971, compared with £939 for the corresponding period of 1894, being an increase of £32. The total receipts for the half-year 1895 are £15,649, compared with £15,750 for the corresponding period of 1894, being a decrease of £101.

BUSINESS NOTES.

Great Northern Telegraph Company.—For the month of October the receipts were £30,400.

British Electrical Manufacturing and Engineering Company, Limited.—The subscription list opens to-morrow, at 10, and closes at 4 p m. on the same day.

Huyton-with-Roby (Lancs.).—The Urban District Council have resolved to oppose any application for a provisional order for the adoption of the electric light.

Metropolitan Electric Supply Company, Limited.—The directors announce the payment of an interim dividend of 3s. per share for the half-year ending June 30.

Southampton—It is stated that the dock authorities, hearing that the Mersey Dock Board have decided to light their stages by electricity, have resolved to similarly light their quays.

Reigate.—Mr. F. H. Medhurst, of 13, Victoria-street, S.W., has been appointed the Corporation electrical engineer to design and carry out a scheme to light the borough with electricity.

Herne Bay.—A town's meeting has passed a resolution in favour of a deep-sea pier being constructed by the Urban District Council or otherwise. An electric tramway is included in the scheme.

Wakefield.—The Wakefield Tradesmen's Association have passed a resolution expressing satisfaction at the action of the Corporation in taking steps to provide the city with electric light.

Harrow.—The Urban District Council have decided that the chairman (Dr. Williams) and Mr. Hawkins should attend the forthcoming Board of Trade conference on electric lighting regulations

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended November 3 amounted to £1,046, as compared with £884 in the corresponding week of last year, being an increase of £162.

Brompton (London).—The committee of the Cancer Hospital, Brompton, have decided to introduce the electric light throughout the hospital premises, and have instructed Mr. Morgan Williams, C.E., to prepare specifications for the work.

Denbigh—The County Council have accepted an invitation from the Merionethshire County Council to appoint a committee with Merioneth and Carnarvon to examine and report on the possibility of constructing a light railway on the Holyhead road from Corwen to Bettwsycoed.

Eastbourne.—The town clerk has received a letter from the secretary to the General Post Office stating that the Postmaster-General had given instructions for the extension of the telegraph to the Upper-avenue Post Office, and that it was to be carried out as soon as possible.

Chelsea Electricity Supply Company, Limited.—Application has been made to the Stock Exchange Committee to allow the following securities to be quoted in the official list: 6,000 6 per cent. preference shares, Nos. 14,001 to 20,000, and a further issue of 3,723 ordinary shares.

English Automobile Horseless Carriage Syndicate, Limited. This Company has been registered with a capital of £5,000 in £1 shares. Object: to construct and deal in locomotives, carriages, etc., wholly or partly propelled by steam, electricity, compressed air, or other mechanical power.

Manchester.—The Corporation's Bill, to be introduced next session, includes powers for the Corporation to run carriages and work tramways within the city, and to provide such plant as may be requisite, and authorises the use of electricity or other mechanical power as a mode of traction.

Bexhill (Sussex).—The report of the clerk to the Urban Council, Mr. F. A. Langham, on the application of Viscount Cantelupe and another gentleman for the consent of the Council to apply for a license for introducing the Electric Lighting Act in Bexhill, has been referred to the Lighting Committee.

Eccles (Manchester).—Alderman Kendall, in moving the adoption of the Town Hall, Tramways, and Electric Lighting Committee's report, said that it would be for the members of the new Council to say whether the electric lighting scheme for the borough should be proceeded with. The report was adopted.

Automotive Syndicate, Limited.—This Company has been registered with a capital of £5,000 in £1 shares. Object: to carry on business as manufacturers of electric, steam, gas, oil, or other motors; as mechanical engineers, metalworkers, steel converters, etc. The directors are E. H. Preen, M. H. Smith, and G. L. Lyons.

Electric Traction in Switzerland.—A syndicate, having its seat at Zurich, has applied to the local and federal authorities for the concessions of several electric metre-gauge road railways, to be constructed in the cantons of Zurich, Argovie, and Zug, the plans and designs having been prepared by Dr. Du Riche Preller, M.I.E.E.

Fort William (N.B.).—At a meeting of the Provisional Committee of the Fort William Electric Lighting Company it was intimated that all agreements had now been adjusted. It is understood that the company will be registered within the next few days, and that operations will be commenced immediately thereafter.

Improved Electric Glow-Lamp Syndicate, Limited.—This Company has been registered with a capital of £5,000 in £1 shares. Object: to enter into an agreement, made October 25, with T. H. Jones for the acquisition of certain patents relating to improve-

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ments in globes for electric glow lamps, and to develop and turn to account the same.

Electric Tramways in South Africa.—The Port Elizabeth electric tramways have been sold to Mr. Henry Butters, of Cape Town, who undertakes, as one of the conditions of the sale, to introduce electric traction on most, if not all, of the lines. Cape Town already has a system of electric lines under way, and the demand for electric motors in South Africa promises well.

Chatham.—The local electric light company having written to the Town Council saying they had orders to place arc lamps on posts upon the pavement in the High-street from private customers, and asking what further notice, beyond three days, the Corporation would require, it was recommended that the Corporation do not sanction the erection of such lamps on the footpaths.

Caledonian Railway Company and the Electric Light.—The Caledonian Railway Company, it is understood, owing to complaints from the inhabitants in the vicinity of their Morrison-street Depôt, Edinburgh, regarding the spray from the Lucigen lights, have decided to remove them and substitute the electric light. The Company at the same time have decided to light their goods yard at Lothian-road with electricity.

Bournemouth.—The Town Council have received a letter from the Board of Trade inviting the Corporation to appoint a representative or representatives to attend a conference, to be held on November 19, with reference to draft regulations for the safety of the public under the Electric Lighting Acts It was resolved to appoint the chairman of the Lighting Committee, the town clerk, and borough surveyor to attend the conference.

Chagford (Devon).—A parish meeting has been called by the Council to vote the amount required for lighting the streets. The Council have accepted the tender of Messrs. Willey for lighting the streets by gas instead of the electric light, and, as a protest against the action of the Parish Council, it was moved, "That this parish meeting refuses to vote any sum for lighting the streets until the Parish Council bring forward a better scheme for lighting."

Bath.—Alderman Sturges has referred to the notice which had been received from the Electric Lighting Company. applying for the Authority's consent to their application for a provisional order. He said he would merely move that the application of the company be nct assented to, remarking that it would be ridiculous for them to do otherwise, seeing that they had already made up their minds to apply for the provisional order themselves. The motion was carried.

East Grinstead (Sussex).—The Urban Council have received a further letter from Messrs. Lucas and Pyke explaining their proposals for the electric lighting of the town, the effect of the letter being that they could supply four times the present light at the same expense. No objection was made to the principle of the matter, and the recommendation made on the subject by the committee was interpreted to mean that, providing the light was installed, the Council should undertake to use it

Llandudno.—The shareholders in the Great Orme's Head Marine Drive have resolved to sell the company's rights in the drive round the Great Orme to the Edison-Swan Electric Supply Company, of Manchester, at a price agreed upon, for the purpose of laying an electric tram round the Orme on the road hitherto used as a carriage drive. It is stated that the company intend applying to the District Council for permission to make a connecting line along Gloddaeth street and North-parade past the Happy Valley, so as to make the circular tour complete.

Whitechapel, E.—The District Board have appointed the Rev. J. H. Scott and Messrs. Brady and Chillingworth as delegates to attend the meeting called by the Board of Trade on the 19th inst., when it is proposed to discuss the various observations and suggestions which have been received by the Board of Trade with reference to the revised draft regulations which have been prepared by that Board under the Electric Lighting Acts, 1882 and 1888, for securing the safety of the public, and for ensuring a proper and efficient supply of electrical energy.

Beckenham (Kent).—The Urban District Council have received a letter from the Board of Trade on the subject of electric lighting, stating that it was proposed to discuss the matter at a meeting to be held shortly, and if the Council desired to be represented they should send the names of those who would attend on their behalf The Clerk said the Council had already a provisional order for electric lighting, but had taken no steps in the matter, and he suggested that some member or officer of the Council should attend the meeting. It was agreed that Mr. C. E Baker and the clerk should again represent the Council at the meeting in question

Fulham (London).—The Vestry have rescinded their decision to light a street in the district with incandescent gas burners on the ground that they were now going fully into the question of electric lighting. The Special Committee on Electric Lighting have reported that of the three electrical engineers who were invited to attend their meeting two attended. but as only six members of the committee were present it was decided to ask them to attend again. The Vestry have decided to hold a special meeting on the 27th inst. to consider the question of applying without delay to the Board of Trade for a provisional order enabling the Vestry to undertake the public and private electric lighting of the parish.

Norwich.—On the order to pay to the National Telephone Company, Limited, the sum of £10 for rent of the telephone wires and instruments for the workhouse and Guardians' office due November 1, a Guardian said that he considered that the rental was most extravagant, and moved that the payment be not made, but that the company be asked to reconsider the rental charged for all the wire used by the Guardians. There was a good deal of competition, and it was expected that the Government would give a new company powers over the lines of the National Telephone Company, so that telephoning would soon be as cheap as talking! The Board eventually decided to leave the matter over until some enquiries have been made.

Clerkenwell.—The Works Committee of the Vestry have reported that the County of London Electric Lighting Company, Limited, applied for permission to drain their transformer chambers into the nearest gullies, but that they (the committee) had refused the application, and informed the company that the drains must be carried into the sewers in the ordinary way. In reply to a question, the surveyor said that the gullies sometimes got choked up, and to his mind there would be very much greater risk of explosion in a connection with a gully than if there was an outlet into the sewer, where there was always a continuous current of air. The report of the committee was then adopted, and it was decided to ask the company what size pipes they intended to go into the sewers.

Newport (Mon.).—The governors of the Newport Intermediate and Technical Schools have decided that the whole of the schools be lighted by electricity. The Newport Corporation have given the gas company notice that they can dispense with the 50 or 60 gas lamps in the area now supplied with electric arc lights, and the gas company is understood to have asked that the Corporation should light up the Corporation-road so as to bring up the consumption of gas for public lighting to the old standard quantity. The Lighting Committee, which has charge of the business, have given hurried directions as to the possibility of lighting the whole of the streets of the borough with electricity, incandescent or arc light, as the occasion might require There the matter stands at present.

The Telegraph Manufacturing Company, Limited, of Britannia Telegraph Works, Helsby, near Warrington, etc., inform us that in consequence of the heavy advance in raw materials they are under the necessity of reducing the discounts on their electric light cables and wires by 10 per cent. from date, and in cases where their invoices have been net prices will be increased by 10 per cent. Customers are also requested to note that existing terms for packages and carriage for cables and wires are now cancelled, and that in future the company will only pay carriage on consignments weighing not less than ½cwt. and all drums and packages will be invoiced at cost price, two-thirds the amount being credited if returned (carriage paid) in good condition and duly advised.

Radnor.—The County Council have received a communication from the General Post Office asking the Council to consent to the erection and maintenance of a line of telegraphs from Boughrood Station to Llyswen Post Office. Dr. Harding moved that the request be granted, and suggested that the Council should take the opportunity of pointing out to the postal authorities that the telegraph facilities for the county were wholly insufficient. Between Kington and Rhayader, a distance of 25½ miles, there was not a single telegraph office erected and maintained at public expense Mr. P. Lloyd added that there was no telegraphic communication between Builth and Glasbury. The motion of Dr. Harding was agreed to, and the clerk was directed to point out the inconvenient state of the telegraph service in the county.

J C Howell, Limited.—The *London Gazette* announces that the firm of J. C. Howell Limited, electric light and power engineers, of 24, Queen Victoria-street, London, E.C., and at Llanelly, have gone into voluntary liquidation. We understand that this has only been done in order to effect a dissolution of partnership between the two managing directors, Mr. J. C. Howell and Mr. Wm. Meredith, in consequence of which Mr Meredith retires from any share in the management of this business. The assets of the old company will be taken over by a new company of the same name, and the usual business will be continued without any interruption on precisely the same lines as hitherto. The liabilities of the old company will be discharged by the liquidator, Mr. S. F. Isitt, of 6, Old Jewry, E C., in due course.

Leeds.—The Highways Committee of the Leeds City Council have confirmed the decision of the Tramways Committee to engage Dr. Hopkinson to report upon the suggested experimental electric tramway line in the city. His engagement, however, will be subject to the sanction of the City Council, which it is proposed to obtain to-morrow (Saturday). A question was asked as to why the choice of the sub-committee had fallen upon Dr. Hopkinson, and the reply was given that he is one of the leading electricians in London, and had previously been employed on behalf of the Corporation. Moreover, it was stated that he is not in any way connected with manufacturers, and therefore has no patents to push. It was generally felt at the meeting that the engagement of Dr. Hopkinson will be of distinct advantage to the Corporation in reference to the experimental trial of electricity as a motor on a portion of the city tramways.

Exeter.—The City Council have received a communication from the Board of Trade laying down the conditions under which they would be prepared to consider the revocation of the electric lighting order granted to the Exeter Electric Light Company in view of the purchase of the undertaking by the Council. It was proposed and seconded that the letter be referred to the Electric Lighting Committee. Mr. Varwell said that he was more than ever convinced that this was to be a committee of meddle and muddle, and that they would be mixing themselves up in a matter

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they did not understand. It was not fair either to put this extra work on the surveyor. Mr. Perry said under the conditional contract entered into they were bound to have the committee. Machinery would have to be purchased, and it was necessary to have someone to see that the Council would not be landed in a greater expense than they anticipated. The motion was agreed to.

Peterborough.—The Lighting Committee of the Corporation have stated that the engineer had reported on the scheme for electric lighting, prepared by him in consultation with Dr. Fleming, and recommended that application be made to the Local Government Board for sanction to borrow £20,000 for the proposed works. Mr. Batten proposed in committee that the engineer reconsider and revise his estimate, and that the members of the committee be provided with copies thereof and also copies of his previous report and estimate, and that the matter be then reconsidered. This was seconded by Mr. Herbert and carried At a subsequent meeting of the committee some discussion took place as to the engineer's recommendation with reference to the amount of loan for which the Local Government Board's sanction should be applied for, and the consideration of the matter was adjourned for the information ordered to be given at the previous meeting to be supplied.

Gloucester.—A deputation have reported to the Town Council that they visited Bristol and inspected the electric lighting installation of the Corporation, and the electric traction installation and the electric tramway of the Bristol Tramway Company, when the various arrangements were fully explained by Mr. George White, the managing director of the tramway company, and the engineers having the control of the works. Mr. George White, with Mr. Kincaid and Mr. Devonshire, attended before the committees and explained the views of the tramway company as to a combined scheme for electric lighting and traction, and explained the lines on which the tramway company and the Corporation might co-operate in carrying out such a scheme. After discussing various details the further consideration of the matter was adjourned in order that further information may be obtained and laid before the committees, prior to the special meeting of the Council to be held on November 12.

Bury St. Edmunds.—Mr. F. W. Turner, the local advocate of electricity, writes to a local paper as follows: "Bury St. Edmunds is most favourably situated for lighting by electricity, being, as it were, in a ring fence without much outlying suburban population. Should the Council allow this opportunity to pass, a company will doubtless obtain a provisional order to light the town, for although Section 1 of the Electric Lighting Act of 1888 protects local authorities, the Board of Trade will not allow any local authority to stand in the way of progress. As a case in point, the Bedford Corporation obtained a provisional order in 1890, but they did not for some years take advantage of the powers given them. A company came upon the scene, and in consequence a deputation from the Council attended the Board of Trade, when Sir Courtenay Boyle said: 'If the Corporation would pass a resolution to supply electricity their order will stand, but if they will not do so within six months their consent will be dispensed with and an order will be granted to a company.'"

Dewsbury.—The Mayor said at the last Town Council meeting that, with regard to the electric light fittings at the new baths and library, the tenders placed before the committee had been fully considered. The committee hoped that some local firm would put in a tender that would enable the work to remain in the town, but from the tenders sent in they did not consider themselves justified in giving the work to a local firm, as the lowest price of the Dewsbury firm exceeded the lowest price sent in by a Bradford electrician, and they felt obliged to accept the lowest tender. He might say they were perfectly satisfied with the Bradford gentleman who had been accepted, as other important works had been carried out by him in other places The difference in the tender was £11. A correspondent writes: "A white elephant! That, according to Councillor Baker and others, was what the Dewsbury electric lighting installation would prove It is gratifying to the promoters to know the 'elephant' is now almost self-supporting, and that in a few months it will probably be earning a profit that may be expected to increase annually. The Heckmondwike Local Authority might have done well to go in for a similar scheme when they had an opportunity. It is said by many, however, that vested interests were too strong. Heckmondwike wants something to make its Market-place more attractive, on Saturday nights especially, and what better could the Council have had than a brilliant illuminant?"

Belfast.—The Town Council have passed the Electric Lighting Committee's report, which contained the following: "Your committee have ordered the extension of the electric light mains to College-square East, Wellington-place, Howard-street, and Arthur-street. They have accepted the tender of the Acme Gas-engine Company to supply and erect two sets of direct-coupled engines and dynamos, rendered necessary by the increasing demand for current. They have requested Prof. Kennedy to represent the Council at the meeting to be held by the Board of Trade to consider the revised draft regulations for securing the safety of the public." In reply to Councillor Herdman, Alderman Pirrie said the committee were pleased to say that all the light that their plant was capable of producing had been applied for. They had on the Electric Committee the able assistance of the Gas Committee. A member of the Council, Mr. Young, had tried to show that the electric light would not be called upon to any considerable extent, but they had ordered two additional engines of 150 h.p. each, which would give them 50 per cent. additional light or 5,000 additional lamps. Electric light was not done, as Mr. Young had told them, but it had a greater future before it than gas, for he believed nine-tenths of their buildings would be lighted by electricity when the committee had permission to put down a large and proper installation.

Birmingham.—With reference to the meeting which has been held to protest against the proposed tramway to Nechells on the overhead conductor system, a correspondent writes to the *Birmingham Daily Post*: "The Nechells controversy in your journal proves once again how extremely difficult it is to remove the prejudices of the English people. We were a decade—shall I say decades?—behind the rest of the world in the establishment of the tramway system in this country, the cause being British prejudice against an innovation. It is now the same with regard to the overhead system. How anyone can hesitate for a moment between the horrible van demon called a steam tram and the overhead system, I cannot imagine Even the trotting horse is not to be compared with it. As to the disfigurement question, it can pretty safely be asserted that this is all a bogey. Have any of your readers visited Brussels lately and seen the overhead system in use there? Brussels is a noble city of splendid avenues, and yet the authorities have not hesitated to adopt the overhead trolley on some of its fine avenues, and the disfigurement does not exist. The pillars there are artistic, and why should not the Corporation of Birmingham insist upon beautiful pillars being erected on the Nechells route? I have no hesitation in saying that once the overhead system is tried in one section of Birmingham in will soon spread, say, to the Bristol and Hagley roads. I see that the Americans have devised a novel system of underground electric traction; all that is visible to the naked eye is a double row of iron contact plugs lying nearly flush with the track," etc.

Copper.—The latest mail reports on the American copper market say that the recent large purchases of Lake Superior ingot at 12c. amounted to nearly 3,000,000lb., if not more, and not to 2,000,000lb., as previously stated. Purchases could still be made at 12c., and indeed buyers at that price were scarce. Business had become moderate in volume, and demand spiritless. Messrs. James Lewis and Son, of Liverpool, in their monthly report say: Some 3,000 or 4,000 tons of American argentiferous pig copper have been sold for forward delivery, and a considerable quantity of Arizona bars were also offered, and realised 5s. to 7s 6d. per ton premium over G.M copper. About 2 000 tons of American argentiferous matte have also been sold during the past month. In New York the value of Lake copper has declined from 12·25 to 11 75 cents per pound. Shipments to Europe for the past month are about 3,920 tons. Imports are 5,694 tons less and deliveries 4,380 tons greater to date than during the same period last year. The total arrivals in England and France for the month have been 7 674 tons, and the deliveries 10 084 tons fine. Stocks have decreased 2,410 tons The arrivals in England from Chile during the month have been 1 566 and the deliveries 2,497 tons fine, and from other countries 3,197 and 4,701 tons fine respectively. The arrivals in England from the United States have been 122 tons bars 53 tons ingots, and 828 tons matte, equal to about 653 tons fine copper, and in France 270 tons fine. The Chile charters for the month are advised as 2,300 tons, and exchange 17⅜d. Sales of furnace material have been confined to: October 2, 55 tons ore, Portuguese, about 11 per cent., to arrive in Liverpool, on private terms.

Bangor (N.W.).—A special meeting of the Bangor City Council has been called to discuss the electric lighting question. Dr. Grey Edwards said that the question had been thoroughly discussed at a previous meeting of the Council, when a resolution was passed that the Electric Lighting Committee be empowered to proceed at once with the scheme in order to be in a position to open electric light works at the end of 1896 They had now to decide whether to give Mr. Medhurst instructions to proceed with the plans at once. The importance of having the light by the end of 1896 was, he said, patent to everyone. The increased demand for light in Bangor was such that they must do something definite. They had been considering that question for the last nine or ten months, and they ought now to arrive at a decision. He moved that instructions be given to Mr. Medhurst to proceed with the plans and specifications, and he hoped they would unite to carry the scheme through. He believed that the majority of the Council were convinced that they should at once go on with the scheme. The small cost of the license would compensate them, as without it they would have to wait until 1897. There were several people who were undecided whether to put in gas or electric light in their houses. He firmly believed it would be of the greatest advantage to the town in every way. Some people advised them to wait until they received revenue from the pier, but he maintained that nothing would pay so well as having the electric light on the pier. At Aberystwyth, for instance, the pier had paid three times as well since the pier and the promenade were lighted with electricity. In Bangor they should go in for the electric light because they had the pier. Mr. E. Clarke seconded the motion. Dr. Edwards's motion was eventually carried, twelve voting for and eight against.

New London Mains.—The Highways Committee of the London County Council reported on Tuesday the receipt of a notice dated October 18, from the Vestry of Hampstead, under the Hampstead Electric Lighting Order, 1892, of intention to lay mains on the east side of Abbey-road, from Alexandra-road to Boundary-road, and on the north side of Boundary-road from Abbey road. The committee have considered a notice, dated October 19, from the County of London and Brush Provincial Electric Lighting Company, of intention, under the County of London (North) Order, to lay conduits for electric conductors from the south-east corner of Farringdon-road to and across Vine street Bridge and alongside

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the Sessions House to Turnmill-street. They saw no objection to the proposed works. They have also considered two notices, dated October 24 and 29 respectively, from the House-to-House Electric Light Supply Company, of intention to lay mains (*a*) on the south side of Wetherby-road; (*b*) in and across Drayton-gardens. The proposed works were unobjectionable. Also a notice, dated October 30, from the St James's and Pall Mall Electric Light Company of intention to lay mains acro's Carnaby-street, in Ganton-street, King-street West, and Argyll-place. According to the plan, the company also propose to cross Regent-street, which appears to be outside the company's area of supply, and the committee were of opinion that the Council's consent should be limited to the portion within such area. The Vestry of St. Pancras have given a notice, dated October 28, of intention to lay mains in and across Great College-street and in Highgate-road. The proposed works were unobjectionable. The committee have also considered a notice, dated October 30 from the Kensington and Knightsbridge Electric Lighting Company, of intention to lay mains in Queensgate-place-mews. They saw no objection to the proposed works.

Stafford.—A correspondent writes: "The lighting of the new County Council buildings is by means of current supplied from the Stafford Corporation mains These are led into the cellars beneath the officials' entrance, where the main throw-over switch is placed; thence the mains are led to the main switchboard in the porter's box, where the current is divided into five circuits, each circuit being provided with a double-pole switch and cut-out. From this board the branch mains are led to the various parts of the building where the distribution-boards are fixed and to which the branch mains are severally connected. No. 1 distribution-board controls the lights in the basement and the electric motors for driving the hot-air and ventilating fans, and probably this circuit will never be cut off, as light will be wanted in the cellars all the year round, and the ventilating motors will be wanted summer and winter. Board No. 2 controls the light in the ground-floor offices, board No. 3 the members' entrance-hall, board No. 4 the committee-rooms, and board No. 5 the Council-hall lights. From the distribution-boards branch wires are led to the various lamps, seven lamps as a rule being placed on each branch circuit. The wires throughout the building are concealed behind the plaster, except in back staircases and other places where the appearance of wooden casing is not objectionable. In all concealed work the casings are laid sufficiently large so that the wires may be withdrawn if necessary The fittings are of plain brass and have a peculiarly graceful appearance. The lamps, which are all frosted, hang from silk cords below the metalwork. The members' entrance-hall is lighted in the daytime by means of a glass dome with skylight above. The dome is glazed with stained glass, and on the top side are a number of electric lamps. Thus light is obtained without glare, and the *summum bonum* of the lighting engineer's ambition—*i.e.*, imitation daylight—arrived at. The general lighting is very effective. The whole contract has been carried out by Mr. W. O. Rooper, C E, of Stafford.

Brazilian Telegraphs.—The following correspondence has taken place in the *Times*: "Brazilian Submarine Telegraph Company, Limited, Winchester House, Old Broad-street E C, November 1. Sir,—In your issue of to-day is a letter from the Western and Brazilian Telegraph Company, Limited, in which it is stated that the tension existing in the present position of the Brazilian Submarine Telegraph Company in Brazil *vis-a-vis* the Brazilian Government referred to at the ordinary general meeting of the members of this company held on Wednesday last is explained in an official report of the Brazilian Telegraph Department, dated August 15 last, as being due to the action of Sir John Pender in relation to the island of Trinidad. I am instructed to state that, so far from this being the case, the differences of opinion between my company and the Brazilian Government commenced in 1892, and were increased in 1893, when a tax was imposed upon our traffic, and were further added to in 1894 by the treatment this company's agent, who was sent specially to Brazil to negotiate with the Government for a removal of all misunderstandings, received at the hands of the Government officials. The Western and Brazilian Telegraph Company, Limited, have always been well informed of all these matters which relate to our joint interests, so that it is strange they should have published so erroneous a statement with regard to the Trinidad incident, which only arose during the current year of 1895. (By order) RICHARD COLLETT, secretary" "The Western and Brazilian Telegraph Company, Limited, Blomfield House, London-wall, E.C., November 2. Sir,—In reply to the letter from the Brazilian Submarine Telegraph Company, I desire to say that for whatever period differences may have existed between the Brazilian Government and the Brazilian Submarine Telegraph Company they are in no way attributable to any action of this company, which has always desired and has always striven to maintain the most friendly relations with the Brazilian Submarine Telegraph Company. As respects the present tension, however, between the Government and that company, the report of the Director-General of the Government Telegraphs will speak for itself.—R. M. CUNNINGHAM, secretary."

Improved Accumulators—Dr. E. Sieg recently described before a meeting of the Elektrotechnische Gesellschaft of Cologne a new kind of battery made at the Cologne Accumulatorenfabrik. It is claimed that the difficulties connected with the casting of the Hagen lattice grid have been overcome by the use of an improved mould which allows of the easy withdrawal of the casting, but even with this improvement it is not possible to cast grids of a less thickness than 4mm., so in the construction of the negative plates the firm employ the form patented by Herr Aloys Zettler, of Munich, which allows of a still thinner lattice. The ever increasing need for portable accumulators has led the company to pay special attention to this type, of which they now consider they have a very good practical form. The plates are kept apart by perforated, waved celluloid separators, which form of construction gives great resistance to lateral pressure, while allowing the electrolyte to circulate. The distance between the plates is reduced to from 2½mm to 3mm. The cells are formed of hardened lead, and are closed with soldered covers. These batteries are claimed to be well adapted for both traction and lighting purposes. The Marienburg Railway uses the Cologne accumulators. Each carriage contains a battery of eight cells. Four wooden cases, each holding two cells with six positive and seven negative plates of 15cm. by 18cm., are connected, and put into a wooden case. Wooden ledges on the front and back of the case press against indiarubber bands, and prevent any movement of the cells. Their capacity is 108 ampere-hours, with 15 volts and 28 amperes maximum discharging current, the charging current being 18 amperes, and the weight 170 kilogrammes (374lb.) The high rate of charge which can be employed with the lattice grid is a special advantage, as the cells can be charged in six hours whilst the German Post Office accumulators require 22 hours. On the Marienburg Railway the accumulators not only serve for the lighting of the trains, but also for that of the platform, the front and end passenger carriages being provided with an arm at each side, by which a 20-c.p. lamp is automatically lighted. The sole agents for the United Kingdom and the Colonies of these accumulators are Messrs. Conze and Simon, of 52, Queen Victoria-street, London, E C.

Wimbledon.—The Local Government Board enquiry into the application of the Urban District Council for sanction to borrow £32,000 for purposes of electric lighting has been conducted by Major-General Phipps Carey, R E. Mr. Fletcher Moulton, Q C., instructed by Mr. W. H. Whitfield, the clerk to the District Council, appeared in support of the application, and it was opposed on behalf of the Ratepayers' Association by Mr. Castle, Q C., and Mr. Fordham Spence. All the members of the District Council were present with one exception. Mr. Fletcher Moulton, Q.C., said he appeared on behalf of the Wimbledon Urban District Council to support their application for the sanction of the Local Government Board to the loan of £32,000, in order to establish a system of electric lighting in the district under their control. Mr. Arthur Preece, A M.I.E.E., stated that he had been connected with his father, Mr. W. H. Preece, in eight or nine electric lighting schemes, including that of Kingston He had acted as his father's sole assistant and was responsible for getting out all the drawings. In his scheme for lighting Wimbledon with electricity the sums put down for capital were amply sufficient to cover the outlay, and the sums he had put down as working expenses were also sufficient. Mr. Manville, M.I.E E, said he had examined Mr Preece's report and heard his evidence, which he fully endorsed. He had fully satisfied himself as to the efficiency of the incandescent electric light for street-lighting, which had proved most successful at Portsmouth, where it was being greatly extended, and it was also being adopted in other large towns, including Swansea and Southampton, as well as Shoreditch. The working cost at Portsmouth was the lowest in the kingdom, which was attributable to the fact that half the current used was consumed in the public lighting, which was constant and reliable. He had not the least doubt that the incandescent light would be much more used for public lighting in the future. He recommended it in every case, and it was most favourable for public authorities. With regard to private lighting, he thought Mr. Preece's estimate was greatly under the mark. His own experience would have led him to double the number of lights for which there would be a demand. He believed there would be a very considerable demand for the electric light for houses under £40 a year. At Portsmouth, in a single street, they had over 1,000 lamps installed, and it was found there that many of the shops and houses only had from two to eight lights. Mr. W. H. Preece, C.B., C.E., past-president of the Institution of Electrical Engineers, and chief electrician to the General Post Office, corroborated the previous evidence, and said in his judgment the incandescent electric light was eminently efficient and economical for public street-lighting. Wimbledon could be lighted far more effectively than at present by means of the incandescent electric system, and at only a slight increase upon the present cost. The incandescent gaslight, so far from seriously competing with the electric light, was doing it an immense amount of good As a matter of fact and experience, the electric light was even cheaper than incandescent gas. He should advocate arc lighting in Wimbledon, as he had done in Kingston, if the conditions were similar. He was a very strong advocate of arc lighting, chiefly because it was such a splendid advertisement for the electric light. Arc lamps could be run from the same mains as the incandescent lamps, so that if it was determined at any future time to establish any number of arc lamps, it could be done. Mr. W. Santo Crimp, C.E, a member of the District Council, said he was very strongly in favour of this scheme, which he believed would be most beneficial to the ratepayers generally. Prof. Silvanus Thompson, M I.E E., described the scheme as a very crude one. It had some good features, but it would prove much too expensive. The figures in the estimate, as compared with the actual expenditure of other municipalities, were too low. Taking the public lighting part of the scheme alone, it would in his judgment be possible to work it much more economically than was proposed. In the series system, assuming that the same number of lamps were to be used over the same area, he thought it would be possible to save £3,000 or £4,000 in the capital outlay. He thought the estimate of 10s. per lamp as the average amount of revenue was excessive. He was a believer in the series system

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for the outlying districts, as he thought it would bring public incandescent lighting to districts which no other system could touch. Mr. W. G. Cooke, chairman of the Ratepayers' Association, repeated his grounds for opposing the scheme, which have frequently been made public. He considered that the estimate was too roseate, that no allowance was made for renewals, and that nearly all the benefits would be absorbed by North Wimbledon. Mr. Moulton, Q.C., having again addressed the inspector on behalf of the Council, the enquiry terminated.

PROVISIONAL PATENTS, 1895.

OCTOBER 28.

20288. **Improvements in electric railways.** William Sharkey Hull, 323, High Holborn, London. (Complete specification.)

20301. **An improved machine for sweeping and cleaning chimneys, also for pushing and dragging lines or ropes through tubes or pipes for electrical or other purposes.** David Walker, 28, Calabria-road, Highbury, London.

20306. **Improvements in electric power storage batteries or accumulators.** Jacobus Langelaan, Barmen, Germany. (Complete specification.)

OCTOBER 29.

20335. **Improvements in electric arc lamps.** Percy Collinson, Sunbridge-chambers, Bradford.

20392. **Improvements in and relating to arc lamps.** Malone Wheless, 77, Chancery-lane, London. (Complete specification.)

20431. **Improvements in secondary batteries** John Joseph Rooney, 40, Chancery-lane, London. (Complete specification.)

20435. **Improvements in electric brakes.** James Devonshire, 70, Chancery lane, London (Frank E. Case, United States.) (Complete specification.)

OCTOBER 30.

20487. **Improvements in connection with electric indicators for signalling between signal-box and station platform.** Edward Wilson Cheyney, Police Office, Waterloo Station, London.

20498. **The novel application of electricity for lighting purposes.** Charles Henry Taylor and Joseph Taylor, 18, Bishopsgate-street Without, London.

20508. **Improvements in non-synchronous alternate-current motors.** Valeré Alfred Fynn and Easton, Anderson, and Goolden, Limited, 1, Queen Victoria-street, London.

20509. **An improved system and means for electrical distribution by alternating currents** Valeré Alfred Fynn and Easton, Anderson, and Goolden, Limited, 1, Queen Victoria-street, London.

20510. **Improvements in dynamos and motors.** Valeré Alfred Fynn and Easton, Anderson, and Goolden, Limited, 1, Queen Victoria-street, London.

20529. **Improvements in the construction of electric railways.** Michelangelo Cattori, 37, Chancery-lane, London. (Complete specification.)

OCTOBER 31.

20542. **Improvements in or connected with apparatus for the electrolytic decomposition of brine.** George Bell and George William Bell, 15, Water-street, Liverpool

20572. **Improvements in and relating to the active material for secondary electric batteries.** Carl Marschner, 37, Chancery-lane, London.

20584. **An improved dynamo-meter or power measurer.** Frederick John Cox, 11, Burlington chambers, Birmingham.

29595. **A device for improving the contact of the wires connecting the several rails of electric tramways.** Carl Dietrich Hastedt, 18, Buckingham-street, Strand, London.

20600. **Improvements in electric incandescent glow lamps.** Reuben James Bott, 9, Park-place-villas, St. Mary's, Paddington, London.

NOVEMBER 1.

20626. **Improvements in electric arc lamps, specially applicable for lantern purposes.** Frederick Woodward Branson, 30, Park-row, Leeds.

20636. **Improvements in or relating to telephone instruments.** Thomas Frederick John Truss, 10, St George's-crescent, Liverpool.

20639. **An improved system of wiring buildings and other places for the fitting up of electric light installations.** John Jennings and Ernest Wilfred Lawson Harrison, 53, Arcade-chambers, St. Mary's Gate, Manchester.

20681. **Improvements in and relating to the ventilation of transformer-boxes, road and junction boxes, conduits, and the like, used in the distribution of electrical energy.** Leonard Penson, 433, Strand, London.

20696. **Improvements in electric switches.** Francis Henry Nalder and Alfred Soames, 24, Southampton-buildings, Chancery-lane, London.

NOVEMBER 2.

20719. **An electric maximum current indicator.** Frederick William Edmund Jones, 23, Archery-road, Leamington Spa.

20728. **Improvements in electric tramcar system.** Alfred Charles Brown and George Richard Neilson, 50, Old Broad-street, London.

20734. **Improved bowl for electric and other lamps.** Alfred Julius Boult, 323, High Holborn, London. (John Lawrence Spink and Thomas Walter Horn, Canada.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1890.

1110. **Galvanic batteries.** Hitchcock. (Burnley.) (Second edition.)

1891.

17324.* **Electric lighting.** G. J. and G. J. T. J. Parfitt. (Amended specification.)

1894.

17065 **Electric cables, etc.** De Ferranti.

19364 **Electromotors, etc.** Connors and Langdon-Davies.

20354. **Electro-deposition of aluminium, etc.** Marino.

21879. **Effecting electro-fusion of metals.** Thwaite and Allen.

23661. **Electric telegraph instruments.** Willmot.

23685. **Brackets for telegraph poles.** Siemens Bros. and Co., Limited, and Perry.

24714 **Secondary voltaic batteries.** Epstein.

25145. **Producing copper by electrolysis.** Mewburn. (Société L'Electrolyse.)

1895.

5878. **Distributing electricity.** Wordingham.

6000. **Electrically lighting miners' safety lamps.** Peel.

10836. **Storage batteries** Payen (Second edition.)

15246 **Incandescent lamp mantles.** Crocker.

16077. **Electromagnetic percussive tools.** Thompson. (Fonda.)

16343. **Incandescent lamps.** Baermann.

16702. **Secondary voltaic batteries.** Vandersmissen.

16924. **Electric fire alarms.** Tisdale and Gould.

16925. **Electric fire alarms.** Tisdale and Gould.

16939. **Electric locomotives.** Devonshire. (Rice.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¾-6¼
Brush Company, Ordinary	3	1¾-1¾
—— Non. Cum., 6 per cent. Pref.	2	2-2¼
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5¼-5¾
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6¾-7¼
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	12¼-13¼
—— 6 per cent. Cumulative Pref.	10	15¼-16¼
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	132-134xd
—— 5 per cent. Pref. Shares	10	14¾-15¼
County of London and Brush Provincial Co., Ordinary	10	8¼-9¼
—— 6 per cent. Cum. Pref.	6	8¾-9¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¼-2¼
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	¾-1
—— 6 per cent. Debentures	—	98-102
—— 7 per cent. Cumulative Pref.	2	2-2¼
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	1-1¼
Fowler-Waring Cables	5	¾-1
W. T. Henley's Telegraph Works, Ordinary	10	14-14¼
—— 7 per cent. Preference	10	15¼-16¼
—— 4½ per cent. Debentures	100	107-110
House-to-House Company, Ordinary	5	4¼-4¾
—— 7 per cent. Preference	5	8-8¾
India Rubber and Gutta Percha Works	10	19-20
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge Ordinary	5	8-8¾
—— 6 per cent. Pref.	5	7-7¾
Liverpool Electric Supply, Ordinary	5	7¾-8¼
Liverpool Overhead Railway	10	11¾-12
—— 5 per cent. Pref.	10	15¼-15¾
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric Supply	5	¾-⅝
Metropolitan Electric Supply	10	10¾-11¼
—— 4½ per cent. First Mortgage Debenture Stock	100	117-120
National Telephone, Ordinary	5	6-6¼
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15¼-16¼
—— 5 per cent. Non. Cum. Third Pref.	5	6¼-6¾
—— 3½ per cent. Deb. Stock	100	105-107
Notting Hill Company	10	8¼-9¼
Oriental and Electric Company, £1 shares	1	1-1¼
—— £5 Shares	5	7¼-7¾
—— £4½ shares	4½	6¼-6¾
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-105
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8¼-8¾
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	42-44
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4¾-4¾
Westminster Electric Supply, Ordinary	5	8¼-8¾
Yorkshire House-to-House	5	6¼-7

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NOTES.

Congress and the Electric Light.—An installation has just been made at the Washington Capitol in order to light the halls of the Senate and House of Representatives with electricity.

Telephonic Communication between Berlin and Vienna is to be reinforced next spring by the laying of a second line, for which the Austrian Government has voted a credit of 300,000fl.

Solder for Aluminium.—Mr. Joseph Richards, in a paper read before the Franklin Institute, Philadelphia, states that he has found that the best solder for aluminium is an alloy corresponding to the formula Sn_4Zn_3.

Dundee Institute.—The council of the Dundee Institute of Architecture, Science, and Art announce that the annual conversazione will be held, by permission of the Fine Art Committee, in the Victoria Art Galleries, on the evening of Thursday, 21st inst.

The Discovery of Argon.—Lord Rayleigh and Prof. William Ramsay have received from the United States Embassy a cheque for 10,000dol., which had been granted by the Smithsonian Institute at Washington as the first Hodgkins prize for their memoir on argon.

Electric Traction in Paris.—We understand that it has been definitely decided to adopt electric traction on the tramways in the Seine division of Paris. The trolley system will be used outside the fortifications, and it is proposed to give the accumulator system a trial inside these boundaries.

Institution of Electrical Engineers.—We are informed that the annual dinner, which was to have taken place on Friday, November 29, has been postponed until Friday, December 13, when H.R.H. the Duke of Cambridge will honour the Institution with his company. A circular to this effect is being issued to the members.

The Electrical Fan in Colombo.—With the introduction of electric lighting in certain public buildings in Colombo, we understand that the time-honoured punkah has been superseded by electric fans. These are connected with the lighting mains, and no sooner are they turned on than sufficient draught is created to cool the whole room.

King Khama and the "Lightning."—To the amiable coloured princes whom we have had and still have with us nothing has been more puzzling than our electrical installations and the subtle power of the electric current. The Shahzada gaze utterance to some highly funny remarks on the subject, and now we have Khama expressing grave wonderment that we "work lightning with our hands and our feet!"

North-East Coast Institute of Engineers and Shipbuilders.—At a meeting of the graduate section of this society at Newcastle yesterday, a paper was read by Mr. J. B. Bent on "Alternating-Current Motors for Use on Single-Phase Mains." The graduates' annual dinner will take place on Saturday, December 7. The third business meeting of the session will be held in Sunderland on Saturday, December 14.

Royal Institution.—The Christmas course of lectures, adapted to a juvenile auditory at the Royal Institution, will be delivered this year by Prof. John Gray McKendrick, M.D., LL.D., F.R.S., professor of physiology in the University of Glasgow, and formerly Fullerian professor of physiology in the Royal Institution. The subject will be "Sound, Hearing, and Speech," and the lectures will be experimentally illustrated. The first lecture will be delivered on Saturday, December 28, at 3 o'clock, and the remaining lectures on December 31, 1895, and on January 2, 4, 7, and 9, 1896.

A New Storage Battery.—A description of a new type of storage battery is going round the American electrical Press. A porous plate is produced by mixing lead and pumice stone while the lead is in a semi-molten condition. The plastic mass is then pressed into a mould, and afterwards, we presume, is formed on the Planté system. The pumice stone is left in. A high capacity per pound is claimed, but is supported by maker's figures only.

Coefficient of Magnetic Dispersion in Multiphase Motors.—Prof. Blondel calls attention to the coefficient used by Dr. Behn-Eschenburg in his theory of multiphase motors, and claims that one of the objections to it is that nothing is said about the nature of the coefficient, or what effect the primary and secondary circuits have on it, also that it leads to a number of errors, and that diagrams based on it are not exact. The whole matter at once becomes clear if instead of the coefficient of induction one introduces directly the magnetic flux, as is done by Hopkinson in his theory of transformers.

Presentation.—On the evening of the 9th a large number of the staff and workmen of Messrs. Ernest Scott and Mountain met at the Collingwood Restaurant, Newcastle, for the purpose of presenting Mr. M. B. Mountain, their works manager, with a token of esteem on the occasion of his marriage. Mr. Wile made the presentation, Mr. Mountain suitably responding and thanking all for their kindness. The present consisted of a silver set of dessert knives and forks, a silver set of fish knives and forks, and also a small spirit case. After the presentation a good programme was provided by some of the employés and a very pleasant evening spent.

Presentation to Sir David Salomons.—Sir David Salomons, who, together with his celebrated engine and dynamo house, was *Sketch*-ed the other week, has been the recipient from the Town Council of Tunbridge Wells of a lengthy illuminated address "setting forth his many good qualities as mayor and his high repute as an electrician and scientist." In thanking the Council for the gift, Sir David said that the unexpected had happened to himself, for 50 years ago, when he came to Tunbridge Wells a tall, lean boy, he little thought he should live to have the honour of being the mayor of Tunbridge Wells; and he incidentally remarked that he should always continue to be interested in the development of the town, especially in connection with the electric light.

The Coming Conference on Light Railways.—Mr. J. Wallis Davies writes from 16, Parliament-street, S.W., under date November 12, stating that the object of the coming conference on light railways, to be held at the Westminster Palace Hotel on Thursday, the 28th inst., under the presidency of Sir Albert K. Rollit, M.P., will be to discuss the furtherance of legislation on that subject. With the view of making the discussion as practical as possible, it has been decided to take the Bill introduced on the subject by the late Government as a basis of discussion. Proposed amendments or substantive clauses in this Bill should reach Mr. Davies not later than Tuesday morning, the 26th inst. It is also desired that those intending to be present at the conference should communicate with Mr. Davies at once.

Electric Traction on Canals.—An official test of a plan for propelling canal boats by electricity has been made at Tonawanda (New York), near where the Erie Canal connects with the Niagara River and Lake Erie, and there is every promise of useful and lasting results. The system used is that of hauling from the bank, as distinguished from driving the boat by a propeller immersed in the water of

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the canal, and has been devised by Mr. Richard Lamb, C.E., and is similar to one which has already been in use elsewhere for canal work and logging in swamps. A 500-volt current is used. At present no data are to hand showing the efficiency of the electrical apparatus, nor is there any other means at hand of making a comparison with the older methods of traction which it is hoped to supplant. But it is said that the State officials and experts present were very favourably impressed with the results of the trials.

The Royal Society.—The following is a list of those who have been recommended by the president and council of the Royal Society for election into the council for the year 1896 at the anniversary meeting on November 30: President, Sir Joseph Lister, F.R.C.S., D.C.L.; treasurer, Sir John Evans, K.C.B., D.C.L., LL.D.; secretaries, Prof. Michael Foster, M.A., M.D., Lord Rayleigh, M.A., D.C.L.; foreign secretary, Mr. Edward Frankland, D.C.L., LL.D.; other members of the council, Mr. William Crookes, F.C.S., Sir Joseph Fayrer, K.C.S.I., Mr. Lazarus Fletcher, M.A., Mr. Walter Holbrook Gaskell, M.D., Mr. William Huggins, D.C.L., Lord Kelvin, D.C.L., Prof. Alexander B. W. Kennedy, LL.D., Prof. Horace Lamb, M.A., Prof. Edwin Ray Lankester, M.A., Prof. Charles Lapworth, LL.D., Major Percy Alexander MacMahon, R.A., Prof. John Henry Poynting, D.Sc., Prof. Arthur William Rücker, M.A., Mr. Osbert Salvin, M.A., Prof. Harry Marshall Ward, D.Sc., Admiral William James Lloyd Wharton, C.B.

The Emperor William and Edison. — Here is another story concerning Kaiser Wilhelm's famous omniscience, which we hasten to reprodace before it is contradicted. When Edison, it is narrated, brought his phonograph to the Imperial palace in Berlin, by invitation, the Emperor took him into his private cabinet, no one else being present, carefully closed all the doors, and then besought him to take the marvellous invention apart and explain to him all its workings. This was done, and the inventor was invited to attend a Court reception next day and to bring the phonograph with him. Upon this occasion Thomas Alva found the Kaiser surrounded by a brilliant throng of nobles, each one decorated with the insignia of his rank. When he produced his mysterious device the Emperor took it in hand, eyed it critically, as though he had never seen it before, and then marched apart with it and explained to the amazed courtiers exactly how it performed its wonders! Not a word was said about his instruction of the day before.

"Autocars."—Mr. G. Croydon Marks, at the opening meeting of the session of the Birmingham Municipal Technical School Engineering Society, gave a lecture on "Horseless Vehicles." Councillor Martineau, who presided, said that in the matter of horseless vehicles England had been behind other nations. It was desirable not only that England should come to the front in this matter, but that Birmingham should come to the front among the towns in the kingdom. This, he believed, the Municipal Technical School would be the means of bringing about. Mr. Marks said that the first successful attempt to make a self-moving road vehicle must be credited to a Frenchman, Nicholas Joseph Cugnot, who was born in 1729. With the aid of an excellent series of 55 lantern slides, the lecturer described subsequent machines worked by steam, electricity, manual, or pedal power, or oil-engines, pointing out from the experience of successful inventors what to aim at and what to avoid, and showing that the greatest successes were obtained by those who combined with mechanical knowledge and skill a realisation of the practical requirements of road traffic.

Telegraphs in Japan.—The growth of the tele graphic system in Japan and the simultaneous growth of technical knowledge of the acts connected with the production of the necessary materials for its construction is well shown by the following facts. Twelve years ago a general scheme was prepared, embracing every city and town of importance and affording every prefect and subprefect the means of communicating with the central Government at the capital. This scheme was so carried out that it paid its way even after the first year, and now they have 8,430 miles of line and between six and seven hundred telegraph stations and offices. "Not a mile of this telegraphic network existed a quarter of a century ago, and at the outset every ton of the material required had to be imported from Great Britain or the Continent. Now the whole of it, with scarcely any exception, is manufactured in Japan, and the Japanese workshops and factories are able to supply such material to their neighbours," and the country possesses a telegraphic system which, "for perfection of organisation, despatch, and reliability combined with a low tariff, is nowhere excelled on the globe," though we may fairly claim equal merit for our own system.

The Electro-Harmonic Society.—A ladies' night has been fixed for Saturday, November 30, at the St. James's Hall Restaurant, Regent-street, W., at eight o'clock. The musical directors are Messrs. T. E. Gatehouse and A. E. Izard, and the programme is as follows: Duo concertante for pianoforte and violoncello, (Mendelssohn), Mr. Alfred E. Izard and Mr. W. C. Hann; song, "The Old Head of Kinsale" (F. Moir), Mr. Franklin Clive; dramatic scenette, "He Fought like a Demon," Mr. and Mrs. Frederic Upton; Russian song, "Vainka's Song" (Von Stutzman), Miss Ethel Bevans; sensational novel, Mr. Frederic Upton; violoncello solos, (*a*) "Sur le lac" (B. Godard), (*b*) "Elfentanz" (Popper), Mr. W. C. Hann; humorous selection, Mr. Cecil Barnard; vocal duet, "It was a Lover and His Lass" (Walthew), Miss Ethel Bevans and Mr. Franklin Clive; pianoforte solo, "Bolero" Op. 19 (Chopin), Mr. Alfred E. Izard; dramatic scenette, "I shall never leave this room alive," Mr. and Mrs. Frederic Upton; old song, "Tom, the Tinker" (Hatton), Mr. Franklin Clive; violoncello solo, "Fantasie sur Carmen" (Hollman), Mr. W. C. Hann; song, "This Green Lane" (Edith Cooke), Miss Ethel Bevans; humorous selection, Mr. Cecil Barnard.

Limits of Electric Power Transmission.—Mr. Alten D. Adams in an article on this subject in the New York *Engineering Magazine* of this month says that "in every branch of engineering there is a wide difference between the physically possible and the commercially practical, and the electric industry has suffered repeatedly from a failure to recognise this fact. During the past year much has been written which might leave the impression that the electric transmission of power over very considerable distances, up to several hundred miles, is a commercially practical undertaking; and that power from Niagara Falls or the coalfields of Pennsylvania can be delivered at the large cities of our Eastern States at a good profit to the promoter." His conclusion is that if alternating current generators and motors to work at 10,000 volts or over can be obtained, or if a number of continuous-current generators and motors are connected in series to attain the desired voltage, it is probable that there are many cases where the transmission of moderate amounts of power from 25 to 50 miles is commercially practical; but for excessively great distances, while "the electrical transmission of power can certainly be accomplished when expense is no object, it cannot compete commercially with that great vehicle of long-distance power transmission—an ordinary coal car."

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The Metric System.—Mr. A. J. Balfour will on Wednesday, the 20th inst., receive a deputation from the Association of Chambers of Commerce in reference to the adoption of the metric system. The following memorial will be presented: "Your memorialists have for many years past taken a deep interest in the subject of decimal weights and measures, as evidenced by the repeated resolutions passed not only by individual Chambers but also by the associated Chambers, in favour of the adoption into this country of the metric system, and your memorialists are pleased to find that the Select Committee appointed by the House of Commons to enquire whether any and what changes in the present system of weights and measures should be adopted have recommended: (*a*) that the metric system of weights and measures be at once legalised for all purposes; (*b*) that after a lapse of two years the metric system be rendered compulsory by Act of Parliament; (*c*) that the metrical system of weights and measures be taught in all public elementary schools as a necessary and integral part of arithmetic, and that decimals be introduced at an earlier period of the school curriculum than is the case at present. Your memorialists therefore respectfully urge upon her Majesty's Government to carry out the recommendations of the Select Committee during the next session of Parliament, by bringing in a Bill for the purpose."

Long-Distance Telephony in India.—A correspondent to *Indian Engineering* considers that the recent "important experiments" in long-distance telephony conducted in India by the Government Telegraph Department, will appear to those at all intimately acquainted with the technique of this science as little more than a waste of time and public money. He states that the conditions under which such telephonic communication can be successfully established have long since been ascertained, and can be predetermined by calculation with sufficient precision for every practical purpose. This has been shown, for example, in the somewhat complicated combined submarine and aerial lines between Buenos Ayres and Montevideo, and also between London and Paris. It is correct that a bronze circuit, weighing about 650lb. per mile, would suffice as regards thickness for speaking between Bombay and Calcutta, but unless the lines be so laid as to counteract induction influences from earth currents and other wires it would be useless. If, moreover, it is in close proximity to powerful telegraph circuits, it is likely that on such a long line at least all the principal telegraph stations should have to be provided with Rysselberghe's graduators. A liberal use of this ingenious device, in combination with the separators of the same celebrated pioneer of long-distance telephony, would render a large number of our copper telegraph lines immediately available for telephonic communications without interference with the ordinary telegraphic work on the same.

A Marine Electric Locomotive.—The electric launch has up to the present been more of a luxury than a commercial competitor with the ocean greyhound. There are some, according to our namesake in New York, who believe that a broader field exists for electrical navigation, and indeed that sea-going vessels will some day be driven electrically. Among these is Mr. A. S. Hickley, of Asbury Park, N.J. It has been Mr. Hickley's idea for many years that the vessels that cross the Atlantic are making too slow time. The reason is, that they cannot drive their propellers fast enough with the amount of power behind them without shaking the boat to pieces. Mr. Hickley's plan is to put a powerful engine, say, a compound condensing Corliss engine of the slow-speed type, connected directly to a multipolar generator giving, say, 500 volts potential. Then directly upon the shafts of the propellers he would put the armatures of the motors which are to drive the propellers. These can easily be made to run from 600 to 900 revolutions per minute, whereas the engine is probably only making 60 to 80. It will be seen that in this way there would be scarcely any vibration in the ship, and the propellers dipping in and out of the water, caused by rough weather, would not affect the main engine and jar the vessel from stem to stern as at present. Mr. Hickley is about to conduct some experiments on this basis, and it will be a matter of surprise if he does not find the losses due to the double conversion more than those due to vibration when the propellers are driven direct by a steam-engine.

Electric Railways Driven by Gas-Engines.—Mr. Westinghouse has prepared a scheme for a trunk-line railway, using gas-engines and producer gas as the motive power, which he described to the directors of the Pennsylvania Railroad when they visited the Westinghouse works recently. He stated that "a strong argument heretofore used against the adoption of the electric system for main lines has been due to the fact that the investment required to make the change would be heavy without materially decreasing the consumption of fuel and other costs of operation—an objection which it is believed can be met by the development and use of gas-engines of large sizes instead of steam-engines for the generation of the electric current." After presenting arguments to show that the gas-engine would use but one-eighth the fuel of an ordinary locomotive to produce similar power, Mr. Westinghouse, continuing, said that "the Pennsylvania Railroad consumes about 5,000,000 tons of coal per annum on its lines east of Pittsburgh, taking, approximately, 20 loaded trains each day for its transportation, and consequently the return of 20 empty trains, and thus requiring for the service of the company alone fully 3,000 cars and a proportionate number of locomotives. If this power were to be generated by gas-engines, only about one-eighth or 600,000 tons of coal per year would be required, effecting a saving of over 4,000,000 tons of coal now costing the railway company above 5,000,000dol., a saving which would justify a large enough capital expenditure to cover the complete equipment of the railway. To carry out an arrangement of this character, stations having electric generating plants with gas-engines and producers could be located at intervals of from 10 to 12 miles, so that there would always be two or three stations furnishing current for any particular part of the line." The *Electrical Engineer* of New York gives further extracts from the speech of Mr. Westinghouse showing the other advantages of the electric system, such as increased speed and less wear on the permanent way.

Potential Drop.—The following on the "drop of the potential along the wire of a Ruhmkorff coil," by M. Wladimir de Nikolaieve, is from the *Journal de Physique* of last month. The author states that each turn is traversed by two magnetic fluxes: one is the magnetic induction along the core, and the other is the result of the self-induction of the coil. Each of these is stated by the author to be the same for every turn, the total E.M.F. in each turn being also thus the same. As the phase of the current at any moment is nearly the same in all the turns, it is seen that the current intensity and E.M.F. are the same for each turn; but the resistances of the turns are not the same, hence there must be something to equalise the currents in them, and this is nothing else than the drop of potential. Considering any single layer of the coil, and if r is its resistance, v the difference of potential between its extremities, E the E.M.F. of the magnetic induction, n the number of layers, and R the sum of the resistances of all the layers, then by

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equating the intensity of the currents in the layer considered and in the entire coil, we have

$$\frac{E + v}{r} = \frac{n E}{R},$$

which gives

$$v = E\frac{n r - R}{R}.$$

This formula shows that there are two drops in opposite directions; in the interior layers the drop is opposed to E, and in the exterior ones it assists E. If the coil were a single turn of homogeneous resistance, there would be no drop, and the current would have no exterior field. But if the turn or ring were composed of two parts of the same length but of different resistances, each part would have its own drop. The value of this fall of potential can be calculated in the case of a sinusoidal current; it depends on the E.M.F. induced by the field of the iron cores and on the resistance and self-induction of the coils.

The Crandall Electric Signal.—What the New York *Electrical Review* of October 30 describes as a promising device for use on sea or land is the invention of Mr. L. S. Crandall, a well-known typewriter inventor. It is a sort of typewriter delivering its message, letter by letter, in mid-air or at any distant point in gigantic characters of light. The observer may be miles away and yet read the message with ease. The keyboard is manipulated precisely as in an ordinary typewriter, and its function is to switch in, or direct the current through, a series of distributing wires, which are carried in a cable to the monogram or display frame. According to a predetermined scheme the keys exercise a selective function and each one switches in the leading wires only, which connect with the members of the monogram constituting the letter of the alphabet which that particular key represents. By reference to the monogram, bearing in mind that each line of lamps in it is a member capable of separate electrical excitation, the reader may easily trace any letter of the alphabet in form so nearly conventional has to be readily understood. Thus, if on the keyboard the A button is pressed, the lamps of all the members of the monogram entering into that letter shine out simultaneously, while all other lamps upon the display frame remain dead. And so on for every letter. The observer has only to follow the letters as they flash out one after another to spell out the words of the message. It will be seen that this is a sort of visual telegraph, and that it may be made to talk in almost any language spoken by man. It is also serviceable for cypher writing according to any prearranged code. Our contemporary adds that commissions appointed by both the Army and Navy Departments of the United States Government have viewed the device and reported favourably upon it. The life-saving service has also endorsed it, together with the signal service of the United States Army and the New York State Militia. It is stated that signals flashed from this frame are visible with the naked eye for distances of from one to three miles, depending on the weather, and that with a glass the signals may easily be read up to 10 miles. We, however, fancy that we have heard of a similar invention which failed to achieve practical success.

Electricity at a Japanese Exhibition.—Electricity was largely used in connection with the recent Japanese National Industrial Exhibition in Kioto or Saikio. The Lake Biwa-Kioto Canal is crossed by several bridges near the exhibition ground. The water-power station and the incline along which boats with cargo were moved up and down on wheeled cradles posed as if they were exhibited machinery. The cradle is hauled by a steel rope passing round a drum, which is worked by electricity generated by the water power of the canal. At this incline the canal branches into two. The main canal for navigation descends 118ft. in 1,815ft. to the level of the city. Double lines of railways, consisting of flat-bottomed steel rails, weighing 75lb. per yard, on wooden sleepers, are laid The gauge is 8ft. 3in. Two cradles, each with eight wheels, are so arranged that one goes up while another is descending. The width of the boat is 7ft., and the length 45ft., the weight of cargo being from 10 to 15 tons. The time of passage of the cradle is about 12 minutes. The electric generating station is situated at the foot of the incline, near the Buddhist temple Nanzenji. Three iron pipes, with a diameter of 36in., are laid side by side. The total quantity of water to be used in the station is 240 cubic feet per second, with a fall of 120ft. When the full power is to be used, 20 120 h.p. Pelton waterwheels are to be constructed. At present only half of the wheels are being utilised. The Pelton wheels are belted with Edison, Thomson-Houston, and Brush dynamos, with countershafts between them. A three-phase Siemens and Halske dynamo was lately laid. Not only are the cradles moved up and down the canal incline by the electric motor, but the electric power is used for spinning, weaving, in the manufacture of clocks, watches, needles, lemonade, ice, in soda-water factories, rolling-mills, rice-mills, pumping water used in bath-houses, etc, which are situated within a circle of two miles from the power station. Besides these, the station supplies electricity in the daytime to the Kioto Electric Railway Company, and at night to the Kioto Electric Light Company. The cost of the power ranges from £4 to £12 per horse-power per year for daily rates of 12 hours; for 18 hours the increase is 30 per cent., and for 24 hours it is 50 per cent. The Lake Biwa is the largest lake in Japan, having an area of 500 square miles, and the canal begins at the south-west extremity of the lake in Otsu, and enters the first tunnel of 8,040ft. long near the famous temple of Miidera, running along the sides of the hills of Yamashina, and piercing two other tunnels, of which the respective lengths are 411ft. and 2,302ft. It is just below this third tunnel that the canal divides into two branches. From the pool at the foot of the incline the canal continues westwards and unites with the Kamo River Canal. The canal turns to the east, passing a little south of the Kobe-Tokio Railroad as far as the Inari station, whence it turns towards Fushimi and finally enters the Uji River. Of the total amount of water—300 cubic feet per second delivered by the canal—240 cubic feet go to the main canal and the remaining 60 cubic feet go to the branch canal, which leads northward at the head of the incline through the fourth tunnel; then it crosses the valley of the Imperial tomb by a handsome viaduct of 14 arches; then after passing two more tunnels it crosses the Takano and Kamo Rivers by syphons, and continues to Kogawa. The length of the canal is 27,690ft. The chief object of this branch canal is the irrigation of ricefields, though it is partly used for power, while the object of the main canal is to open the navigation and to produce electric power. The length of the main canal is 36,650ft., and the difference of the level is 140ft.

The Telephone in Holland.—Herr A. Kruyt has recently published in the Dutch journal *Electra* an elaborate article on telephony in Holland. The telephone systems come within four categories: (*a*) Systems which are erected within a township—(1) private, (2) public; (*b*) systems which connect suburbs and property outside the town limits with the town lines; (*c*) interurban connections; (*d*) international connections. From 1880 to 1884 the telegraph authorities granted 126 concessions for

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private telephone lines; from 1885 to 1889, 123; and from 1890 to 1894, 100 concessions. The first license for the erection of a public telephone system was one for Amsterdam, accorded in November, 1880, to the International Bell Telephone Company. In February, 1881, this concession was transferred to the Nederlandsche Bell Telephoon Maatschappy of Amsterdam, which rapidly acquired licenses in other parts of Holland. There are at present in operation in Holland 30 town telephone systems; and others are in course of erection. The annexed table compares the rates and the extent of the traffic of the various telephonic systems in the Netherlands.

Town telephone system.	Annual subscription.	Central offices.	Public call offices.	No. of subscribers: Total.	No. of subscribers: In proportion to the population. One subscriber to inhabitants.
	fl				
Amersfoort	40	1	1	37	406
Amsterdam	118	5	6	1,830	246
Arnhem	60	1	2	294	257
Baarn	60	1	1	10	430
Bussum	60	1	2	5	600
Dortrecht	51	1	2	251	119
Haag	110	2	7	387	362
Groningen	60	1	3	177	288
Haarlem	60	2	3	169	272
Hilversum	40	1	1	52	231
Maassluis	60	1	1	1	—
Rotterdam	118	1	8	963	239
Schiedam	60	1	1	58	431
Utrecht	60	1	4	211	379
Vlaardingen	40	1	1	25	440
Zaandam	60	1	1	12	1,167
Breda	35	1	—	174	137
Deventer	35	1	—	155	156
Bois-le-Duc	35	1	—	158	182
Leeuwarden	35	1	—	160	194
Leyden	35	1	—	255	174
Middelburg	35	1	—	120	145
Tilburg	40	1	—	163	218
Vlissingen	35	1	—	67	228
Zwolle	35	1	—	172	164
Alkmaar	30	1	3	82	195
Helder	30	1	2	60	416
Enschede	30	1	1	147	177
Nymegen	35	1	—	482	74
Zutphen	35	1	—	141	123
Maastricht	35	1	3	224	147

In December, 1887, some years after the installation of the interurban system in Great Britain, America, Germany, and Switzerland, the Bell Maatschappy obtained from the Dutch Government the first interurban privilege—for a line between Amsterdam on the one hand and Haarlem and Zaandam on the other. Other interurban lines have since been established, notably between Rotterdam and the capital. In less than five years the Bell Maatschappy had connected all their town systems with each other at a cost of 150,000fl., while the expense to the State for posts and insulators amounted to less than 85,000fl. According to the report of the telegraph authorities, the number of interurban conversations during the past five years and the State receipts have been:

	Conversations.	Receipts (fl.).
1890	49,531	17,130
1891	61,031	20,368
1892	71,833	23,179
1893	79,414	30,727
1894	85,147	37,214

These figures relate only to conversations between subscribers. The complete number of "telephonic interviews" during 1894 would probably be about 110,000.

Statue to Benjamin Franklin.—It is announced that a fine bronze statue of Benjamin Franklin will be placed in Lincoln Park, Chicago, the gift of the Hon. Joseph Medill. Accompanying his offer Mr. Medill sends a brief statement to the commissioners explaining his reason for desiring the placing of a suitable memorial of the great American patriot, scientist, and statesman in the public park, in which he says: "He is undoubtedly one of the three or four greatest men our country has produced. His name and fame are world-wide. His works will be of everlasting benefit to his countrymen. He reflects lustre on the American name. Holding him in this estimation, I have deemed it a personal duty to help keep his memory fresh in the minds of Chicago's youth." Upon this the *Western Electrician* of October 26 remarks: "This is a graceful tribute to the memory of a man the value of whose work in behalf of his country and in the interest of science is becoming more apparent as years roll by. That he was not fully appreciated in his day is not strange; few great men are, and there are very few whose work has been of such great value as was that of this eminent American. We must remember, too, that in his own country not only was he without an equal, but there were very few who were capable of properly estimating his great ability. In England and in France, the scenes of his most important diplomatic achievements, his reputation was established by actual comparison with the leading men of the two most powerful nations of his time. When it is remembered that his introduction at the Court of Louis XVI. was the occasion of much mirth among the gay attendants, and that the very simplicity of his dress was the cause of much ridicule, the disadvantages he laboured under at the French Court make his subsequent achievements as a diplomatist appear all the more creditable to himself, the cause he advocated, and the country he represented. Few men received such honours as were paid to him when his real character was understood. It was fortunate for him and for his country that he was selected for the missions to England and to France, for no one could have better represented the Colonies, and nowhere could he have found a better field for his labours. In London and in Paris must be found, if anywhere at that time, men who could rightly measure his ability and accomplishments. Boston, his native town, and Philadelphia, which was his home in later years, were filled with patriotic citizens eager to do service for their country, but they could not understand the magnitude of Dr. Franklin's undertaking, nor the value of his labours abroad. Then, too, there were few men in America in his day who had any idea of the greatness of his work as a scientist. Even at this late day it is only too evident that Franklin's biographers have failed to grasp the situation in this particular, at least those of them who chronicle his achievements for the information of the general public. In works of a purely scientific character due credit is given the eminent electrician for his experimental work in this line at least and his intelligent observation of electrical phenomena. But it may be said that the scope and quality of his scientific work are not generally understood. As illustrating this point, it is only necessary to refer to any of the popular lives of Franklin. Examine, for instance, that in the 'American Statesman Series,' which is, by the way, one of the most appreciative of these works in other respects, and only occasional allusions will be found to his scientific discoveries and the rank to which he attained in the scientific world. Under the circumstances, then, anything that will awaken an interest in this great American patriot must be welcomed not only by Chicago but by America, and the entire world in fact. We cannot know too much of the character and work of this illustrious philosopher, probably the greatest diplomatist and scientist of his country, and certainly one of the greatest of his age." Our contemporary might, further, have illustrated the reserve for which Franklin, like Napoleon, was so famous and to which the one attributed the success—so far as it went—of his diplomacy, and the other in a measure his success on the field of battle.

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CITY AND GUILDS EXAMINATIONS, 1895.

We publish herewith the best set of answers sent us to the questions in the preliminary stage of the City and Guilds examination paper of 1895, in reply to our offer of book prizes in May last. We hold the report of the gentleman who adjudicated on the matter for us, and from it we gather that the answers sent in in this stage were, on the whole, satisfactory. The sketching and diagrams are decidedly better than those sent with the ordinary-grade papers. The remarks of the examiner on the various replies are printed after the questions they refer to. The best set of answers, given below, is by Mr. H. Morgan, of 27, Castle-street, Barry, and we shall have pleasure in forwarding to him books to the value of one guinea as soon as he has made his selection.

ELECTRIC LIGHTING AND POWER DISTRIBUTION.

PRELIMINARY EXAMINATION

1. Give a diagram of the Post Office form of Wheatstone bridge, showing the connections.

Note.—The diagram sent by this candidate, although quite correct, was not suitable for reproduction. The replies to this question show a good general knowledge of the Post Office bridge details.

2. Why are electric bells apt to work badly when coupled in series?

Answer.—Electric bells are apt to work badly in series, because of the irregular breaking of the circuit due to the action of the contact breaker. Single-stroke bells, provided they are similar to each other and that the E.M.F. of the battery is increased in direct proportion to the number of bells in series, will work in series. There is a trembling bell in the market which is intended to work in series, but it does not depend for its action upon a contact breaker, like the ordinary trembling bell. When the armature is attracted, instead of breaking the circuit, it "makes" a contact, which shunts the coils and thus retains the circuit. Though the bell is better for series working, it has not the satisfactory action required in a good ringing bell.

Note.—Only one candidate out of the whole number knew of the simple solution to this difficulty. If two similar bells are connected in series and the contact-breaking arrangements of one are short-circuited so that the magnets only are in circuit, then the contact breaker of the other bell will control the two, and they will work well together. The bells must have similar armatures, hammers, etc., so that the periodic time of the moving parts are practically the same.

3. Where should fuses be placed in an electric lighting installation? And why?

Answer.—Fuses are used in an electric light installation to protect the conductors from overheating. Main fuses should be placed as near the terminals of the source of supply as practicable, so as to leave as short a length as possible being unprotected. Fuses should also be put where a branch is tapped off a pair of mains, and wherever a conductor is reduced in size, because a smaller wire would get overheated by a given current, when a larger wire would carry it without being overheated. Each lamp should also be protected by a fuse, and if there is a switch for each lamp it should be put in the switch because it would be handier to get at, otherwise it should be placed in the ceiling rose. In providing an installation with cut-outs, consideration should be given to the fact that every cut-out is more or less an additional source of breakdown, and also that each one is an additional point to earth. It is not much good using high-class insulated cables when the installation is crowded with switches, cut-outs, and ceiling roses. As a rule, they have large contact surface, and very often inferior to the insulation of the cables. Therefore, wherever practicable, such things should be avoided.

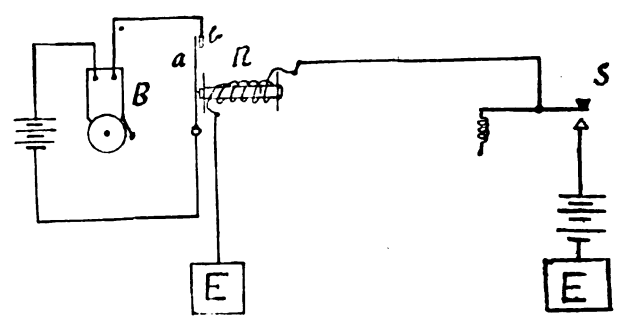
Note.—The last part of this answer is rather contradictory to the first part, but it shows that Mr. Morgan has experienced trouble through the bad insulation resistance of some makes of fuses and switches. These adjuncts to a wiring system must be used, and it only remains to select good makers' wares.

4. A dynamo is 100 yards from a house, the conductor has a resistance of 0 002 ohm per yard, and there are 150 30-watt 100-volt lamps to be fed. What E M F. must the dynamo give?

Answer.—The resistance of 200 yards (main and return) of conductor at ·002 ω per yard = (200 × ·002) = ·4 ω. Total number of watts = 30 W × 150 = 4,500 watts, and since $W \div E = C$ $\therefore \frac{4500\ W}{100\ V} = 45$ amperes. Again, E.M.F. = C × R, $\therefore$ ·4 ω × 45 a = 18 volts, which is the drop in voltage along the conductors—assuming that all the current is taken off at the extreme end. The lamps will require 100 volts at their terminals, and allowing 18 volts for waste in the conductors, therefore the dynamo must give 100 + 18 = 118 volts (E.M.F.).

Note.—Almost all the errors in the answers sent in to this question were due to the candidates taking 100 yards as the total length of the cable, and hence neglecting the return wire.

5. Give a diagram with connections of a relay working an electric bell.



Answer.—The above sketch shows a relay, R, working the electric bell, B. The station, S, might be so far away that the current from its battery is too feeble to ring bell, B. When the current passes through relay it attracts the armature, *a*, and makes contact with terminal, *b*, and completes the local circuit so that the local battery rings the bell.

6. How would you test the insulation in a building you had wired?

Answer. — Assuming the whole was completed with fittings, etc., and lamps removed, I would require an ohmmeter and a small generator. I would turn all switches towards "on" and put all fuse wires in their places.

First Test: Insulation towards Earth.—I would connect one terminal (−) of generator to a good earth, the other (+) to meter, and the remaining terminal of meter to the conductor of main cable the insulation of which is to be tested. Then turn the handle of generator at a moderator speed. The meter would indicate the insulation in megohms. I would then take the other main conductor and treat it similarly. After this I would take both cables together and apply the same test.

Second Test: Insulation between each Conductor (Short circuit). I would remove my earthed connection and connect it to the conductor of one of the main cables and my other connection to the other cable. I would thus obtain the insulation between the two conductors, lead and return. On referring to the regulations according to which the wiring is to be carried out, I would find whether the wiring is satisfactorily done as regards the insulation of it.

Note.—This answer shows a knowledge of what tests are required, and hence in a sense is quite correct. In using an Evershed ohmmeter, however, both terminals of the generator are connected to the ohmmeter.

7. What are transformers, and what are they for?

Answer.—There are two kinds of transformers—first, for alternating currents; and second, for direct current. An

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alternating current transformer is simply a modification of the induction coil with no contact breaker. It consists of two coils of wire and an iron core; the coils are wound separately, one of a coarser and the other of a finer size, placed side by side, as in Statter's transformer. Sometimes they are both wound one on the other around the iron core, as in the Hedgehog transformer. The coils are well insulated from each other with mica or some other good insulator. A current is supplied to one coil, and the current in the other coil is generated by self-induction, which is a very important part played in alternating currents by the continual reversal of the current. A direct current has no self-induction except on "making" and "breaking" the circuit, hence the necessity for a contact breaker in an induction coil which is supplied with a direct current. A continuous-current transformer is an electromotor with two armatures and two commutators on the same spindle. They may be used to transform a current from a high E.M.F. to a low E.M.F., or from a low to high, the former most often. By their use we are enabled to transmit electrical energy economically over a long distance, because a small current at a high E.M.F. may be carried by a small wire but well insulated, and then be transformed down to a low E.M.F. and large current, as may be required to suit the consumers.

Note.—Most of the replies show a knowledge of the essential parts of an alternating-current transformer, but not more that 25 per cent. contain the ruling principle that the voltage in the two circuits varied directly as the number of turns in each circuit. Unfortunately, a larger number of students state that the E.M.F. varied with the resistance of the circuit. The reply above shows rather a hazy notion of the subject, and the student evidently thinks that the mysterious term "self-induction" will cover the want of accurate knowledge. It is mutual induction, rather than self-induction, that effects the transformation.

8. How many 16-c.p. lamps, taking four watts per candle, can be run off a dynamo giving 7 e.h p. ?

Answer.—7 e.h.p. = 746 × 7 = 5,222 watts; 16-c.p. lamp taking four watts per candle = 64 watts ∴ number of lamps that could be run off dynamo = 5,222 ÷ 64 = 81 lamps, and we have a surplus of 38 W, which would not be sufficient for one more lamp. No consideration is made for loss in cables.

9. Why can a leaden bullet be fired further than a piece of wood of same shape and size?

Answer.—Suppose we drop a piece of lead and a piece of wood of the same size and shape in a vacuum, both would reach the floor the same time precisely. Now, drop both in air, the piece of lead would reach the floor first, because the lead is denser—that is, there is a greater number of particles occupying the same amount of room, and proportionately it receives less obstruction due to the resistance of the air. We have the same amount of rubbing surface in both, but we have more matter in the piece of lead. For the same reason a lead bullet can be fired further than a piece of wood of the same size and shape.

Note.—Some shaky answers have been received to this question. The correct reply is that the energy stored in a moving body is equal to the product of its mass into half of the square of the velocity. Hence, assuming the bullets to start with equal velocity, the lead bullet having more mass will have more stored energy and go further.

10. If a man supports a weight of 10lb for 17 minutes, does he do any work? If so, how much?

Answer.—He does no work. He simply supports the weight against the force of gravity. We are not given that the man lifts the weight any distance. This sort of work is measured in foot pounds (ft.-lbs.). The amount of work done is directly as the weight and distance, and the power of doing work directly as the weight, distance, and time in seconds.

11. What are watt, pound, horse-power, volt, ampere, and ohm? Give any relations you can between them.

Answer.—Watt is the unit used for measuring the rate of doing work in an electrical circuit and is the same as horse-power in mechanical work: 1 watt = 1 volt × 1 ampere; $W = C \times E$; and since (by Ohm's law) $E = C \times R$, $\therefore W = C^2 \times R$. One watt acting for one second does one joule of work. That is, a current at the rate of one ampere along a wire whose difference of potential at its ends is one volt, or whose resistance is one ohm in one second, does one joule of work.

Pound is a factor of the unit used in mechanical work for expressing work done in foot-pounds. One pound raised 33,000ft. = 33,000 foot-pounds of work; or 33,000lb. raised one foot also = 33,000 foot-pounds. One pound is analogous to R, E, or C in electrical work as being a factor of the unit.

Horse-power is the unit used for measuring the power of doing work: 33,000 foot-pounds of work per minute = 1 h.p.; and 1 h.p. = 746 watts = 1 e.h.p.

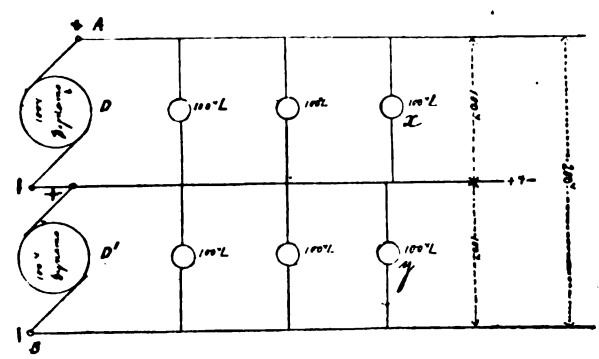
Volt is the practical unit of electrical pressure, and is equal to 10^8 in terms of the C.G.S. system of units, and is that pressure if steadily applied to a conductor whose resistance is one ohm, and will produce a current of one ampere.

Ampere is the unit rate of flow of current along a conductor, and is that rate which caused to flow through a solution of silver nitrate will deposit silver at the rate of ·001118 of a gramme per second. According to the C.G.S. system, it is equal to $\frac{1}{10}$.

Ohm is the practical unit of electrical resistance, and is equal to the resistance offered to a column of mercury 106·3 centimetres long and one square millimetre in sectional area at a temperature of melting ice, and is equal to 10^9 in terms of the C.G.S. system.

12. What is the three-wire system, and what is the good of it?

Answer.—The three-wire system is a system in which two dynamos are connected together in series, as shown in the figure. The two outer leads are connected to the outer



terminals of the dynamos, and a central wire is connected to the wire which connects both dynamos together. When the six lamps are burning, all the current would leave at the terminal A, and would return at B. Supposing lamp *x* went out, then the central wire would act as a + lead for dynamo, D, feeding one lamp on the other side. Again, supposing lamp *y* went out, the central wire would act as a − lead for dynamo, D, feeding the odd lamp on the other side. Thus it will be seen that when the number of lamps are equal on both sides, the central wire carries no current. It simply acts as a balancing wire if the number of lights be unequal on either side. There is 200 volts pressure between the outer leads, and between the central and either of the outer leads there is only 100 volts. It is used for street mains for lighting densely populated areas where the supply station can be placed in the middle. It may also be used for wiring large buildings. There is a great saving of copper with this system—the outer leads only carrying half the current that would be required for the same number of lamps on the ordinary parallel system, whilst the central wire, which acts only as a balancing wire, need not be so large a size as either of the outer leads. The chief object of this system is the wide distribution, and at the same time saving a great amount of copper. It has also the advantage of being a low-tension system. Although we have a pressure of 200 volts between the outer conductors, only 100 volts need be taken into the consumer's premises.

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13. Two lamps of 100 and 150 ohms each, when running, are put in parallel with each other, and the pair is put in series with a lamp of 100 ohms. What E.M.F. will be needed on the system in order that it may consume 250 watts?

Answer.—The joint resistance of the two lamps in parallel is $\frac{100 \times 150}{100+250} = \frac{15{,}000}{250} = \frac{300}{5} = 60\,\omega$ When the other lamp is put in series we get a total resistance of $(60\,\omega + 100\,\omega)$ $160\,\omega$. Now, $W = C \times E$; and since (by Ohm's law) $E = C \times R$, $\therefore W = C^2 \times R$, and $\therefore C^2 = W \div R$; $\therefore$ the square of the current equals $\frac{250}{160} = 1{\cdot}56$. $\sqrt{1{\cdot}56} = 1{\cdot}24$ amperes (nearly).

Again, since $E = C \times R$, $\therefore 160\,\omega \times 1{\cdot}24\,a = 198{\cdot}4$ volts, which would be the E.M.F. required. These figures are a little too low.

Note.—The only error here is in taking the square root $\sqrt{1{\cdot}56} = 1{\cdot}25$, hence $E = 160 \times 1{\cdot}25 = 200$.

14. What is generally the difference between voltmeters and ampere-meters of the same type?

Answer.—The general difference between a voltmeter and an ampere-meter of the same type is a voltmeter is wound with "many" turns of fine wire, and is connected as a shunt across the circuit, and indicates the difference of potential between the two points of the circuit where it is connected in. An ampere-meter is connected in series in the circuit, so as to take all the current passing, and indicates the number of amperes passing; it is wound with a "few" turns of thick wire.

15. Why does an electromagnet pull so much less if you take out the iron core and replace it with a brass one?

Answer.—Because brass is not a magnetic body. It has no conductance for lines of force or magnetic flux. Soft annealed iron is the best magnetic body. When it is used as a core for an electromagnet it concentrates the lines of force—brings them more central or more together in the centre—and very much increases the pull of the electromagnet. Brass does quite the opposite, hence the difference. It is often used as a regulator for induction coils.

Note.—The whole of the answers show a want of knowledge of the magnetic properties of iron. All speak of a concentration of the lines of force as though that was the sole action of the iron core, and neglect the fact that the permeability of the iron increases the total number of lines flowing by some thousandfold at least.

16. Why are glow lamps generally run in parallel and arc lamps in series?

Answer.—Parallel running is more satisfactory for glow lamps than series. It would be practically impossible to run a great number of glow lamps in series. Suppose we had 20 glow lamps in series, and each requiring 100 V, we would an E.M.F. of 2,000 volts, which would be decidedly dangerous for incandescent lighting. Another great nuisance would be to have an automatic cut-out for each lamp. Series running is most satisfactory for arc running. Arc lamps take, as a rule, from 10 to 15 amperes at about 40 or 50 volts. Suppose we had 20 arc lamps parallel requiring 15 amperes each, 20 lamps would take 300 amperes. This number of arc lamps would light a large area or great distance, hence we would require very large conductors to carry this current without suffering a great waste of energy in the conductors.

17. Define the terms: insulation, insulator, battery, switch, condenser, electromotive force, relay, depolariser, vacuum tube, electrode.

Answer.—Insulation is the protecting of conductors from all external substances—the protecting of a conductor, so that no current can leak to earth or other substances.

Insulator is the name given to a substance which is used for protecting conductors, and through which no current will pass. There is no such a thing as a perfect insulator, although we have some very good insulators.

A battery, whether a primary or a secondary, is a source from which we derive electrical energy by the chemical action of liquids and metals.

Switch is an apparatus by which we turn "off" or "on" electrical energy in a circuit, and serves for the same purpose as the "tap" in gas or water.

Condensers are used for storing electrical energy or increasing the capacity of the conductors.

Electromotive force is that force which causes a difference of potential between two points, and a current of electricity flows from the one point to the other when connected together.

Relay is an electromagnet in which is an armature, which, when attracted, completes a local circuit. It is generally used in electric bell circuits.

Depolariser is the substance used in primary batteries for preventing the battery polarising, such as dioxide of manganese, bichromate of potash, chromic acid, etc.

Vacuum tube is a tube of glass from which the air has been partially excluded, and platinum wires are sealed in at each end, in which beautiful effects are produced by means of the secondary current of an induction coil by passing sparks through the tube.

Water may be decomposed by passing a current of electricity through it. The process is called electrolysis, and the tips of the wires which enter the liquid are called the electrodes, whatever substance the conductor may be. One is called the positive electrode and the other the negative electrode.

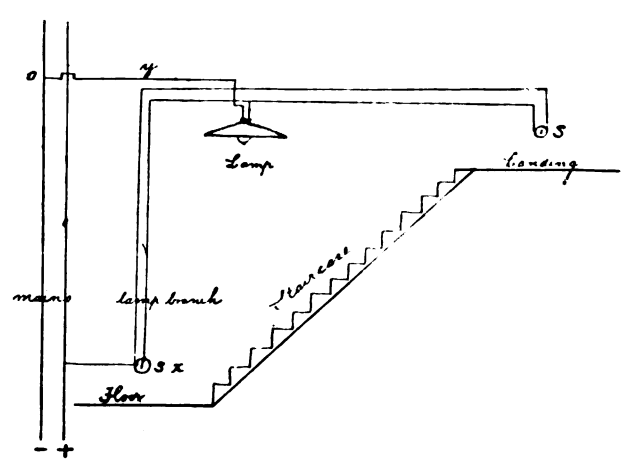
18. What is the white metal used for the tips of the contacts in electric bells? Why is silver not used for this purpose?

Answer.—The white metal used for the tips of the contacts of electric bells is platinum. Silver would be more expensive. There is continual sparking at the contact breaker of an electric bell. The amount of sparking depends on the E.M.F. and the kind of metal. This spark fuses the parts and causes a bad connection. Platinum is only fusible at a very high temperature, and keeps the contact good.

Note.—This answer is wrong. Platinum is used because it does not oxidise.

19. Sketch the arrangement of wires and switches that would enable a staircase lamp to be turned off or turned on from either the foot of the stairs or from the head of the stairs.

Answer.—The sketch shows an arrangement by which a staircase lamp may be switched on or off at the foot or the



head of the staircase. The casing from x to y of lamp branch may be run on top of the main casing, and would be less conspicuous. I would join the return wire into main at o. I would prefer bringing + wire of the "landing" switch down to the other switch, and connect it into the terminal, so as to avoid cutting the insulation of the mains as much as possible, because every additional joint is a weak point. No cut-outs are shown; I think a fuse in the ceiling rose would be sufficient. The switches may also be provided with a fuse wire each, but I would not consider it necessary for reasons given in *Answer 3*.

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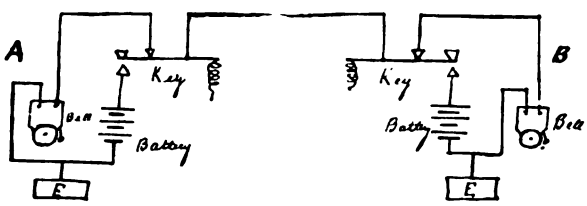
Note.—No one has given a fully correct answer to this question. The diagram shows a method of switching the lamp on from either place, but it must then be switched off from the same place. To get the correct arrangements, the switches must be of the two-way type, and the wire from the positive wire and the positive lead to the lamp connected to the two handles respectively. The two wires shown between the two switches will then be connected to the two contacts in each switch; then they can be switched on at one place and off at the other.

20. There is an electric bell at A and another at B, with a single line of wire between them. Show by sketches what arrangement of cells and switches are required that a person at either end can call up on the other bell without ringing that at his own end.



Answer.—The above sketch shows how the man at the point A may ring B bell without ringing his own bell, and also the man at B can ring A bell without ringing his own. There is only one line wire, and the earth is used for a return.

THE LECLANCHE PRIMARY CELL AND ITS MODIFICATIONS.

BY J. WARREN.

The earliest and best known form of Leclanché cell consists, as all electricians know, of an outer glass containing vessel, square in form, and having a spout-shaped recess in one corner for the reception of the zinc or negative element, which latter is cast in the form of a rod, and has a stout piece of tinned and braided copper wire cast into its upper end to form a terminal or means of connection to the external circuit.

The carbon or positive element takes the form of a plate of gas-retort or specially-prepared carbon surrounded by granules composed of black oxide of manganese and coke which have been subjected to a heating process, under which they combine in a mechanical way, and are then broken up into small pieces of the required size.

The whole mass, with the carbon plate placed vertically in the centre, is packed in a circular porous pot, and sealed to a depth of about ½in. from the top with pitch, two small pieces of glass or ebonite tubing being introduced as vents for the admission of air or the escape of any gases which might be generated from impurities in the carbon. In some forms of the cell the carbon plate is perforated by two holes, about 1in. apart at its upper end, and a lead cap with a brass terminal screw and nut is cast on, the end of the carbon having first been immersed in hot melted paraffin wax, to guard against creeping of the electrolytic solution. The lead is cast all round the head of the carbon, and fills the two holes provided for the purpose, thus mechanically fixing itself against being pulled off by accident.

The drawback to this form of terminal cap lies in the fact that after a time, however well it may have been guarded against, the sal-ammoniac in the cell will creep up between the inner surface of the lead cap and the carbon and form a white deposit of chloride of lead on the former, completely destroying the metallic contact, and thus greatly increasing the resistance of the cell. It is advisable, therefore, to dispense with the lead cap and bring the plain end of the carbon up about ½in. above the surface of the pitch, attaching the wire to it by means of a clamp terminal, which can at regular intervals be removed and its surfaces of contact cleaned.

It is usual to immerse the top of the rim of the porous pot to a depth of about 1in. in melted paraffin wax before using, keeping it there for a few minutes to allow the melted wax to fill the pores. This precaution will also assist in preventing creeping.

In cases where the cell is to be used in conjunction with many others for the production of a high potential or testing purposes, etc., it is generally completely sealed, the charged porous pot and zinc rod being first placed in position in the outer jar; the latter is then filled with dry sand to within ½in. of the top, two glass tubes are placed in position, as in the case of the porous pot, and melted pitch or marine glue is then poured in until it is level with the top of the cell. When it has set, the sand is poured out through one of the tubes and the saturated solution of sal-ammoniac added until the outer jar is quite full. It is then allowed to stand for about 24 hours to give the solution time to percolate through into the porous pot. The level of the solution in the outer cell will then be found to have fallen to about three-quarters of the depth of the jar, or a little below the neck, and a small quantity of sal-ammoniac may be added to keep the solution saturated. The amount of undissolved salt should not, however, exceed ½in. in depth at the bottom of the jar. The ventholes may now be temporarily closed by small corks, and the cell inverted and immersed to a depth of from 1in. to 1½in. in a vessel containing melted paraffin wax. The cell being again placed in an upright position, and the vents unplugged, it is now in a fit condition to be put to work, and should last for months without attention.

Another very convenient form of this element is that known as the "agglomerate" Leclanché cell. In this type the crushed coke and dioxide of manganese are mixed with a certain amount of tar, and compressed into rectangular blocks, which are then baked. One of these blocks is placed on each side of the carbon plate, and the whole is secured by two indiarubber bands provided with a perforated lug at one corner for the reception of the zinc rod. The porous pot is thus dispensed with and the internal resistance of the cell diminished.

Several of the most well-known forms of so-called "dry" batteries being modifications of the Leclanché element, I will here give a description of two of them.

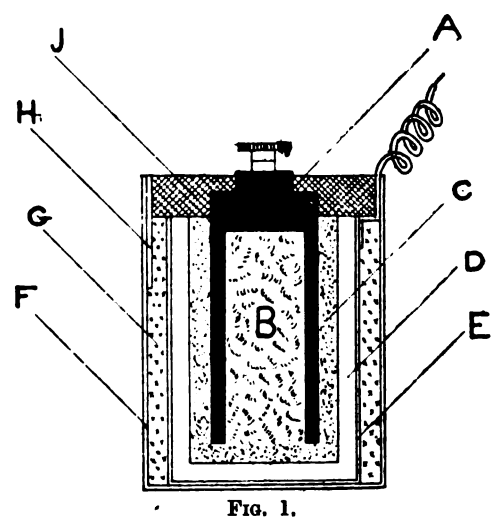


FIG. 1.

To begin with, the Hellesen dry cell, supplied by Messrs. Siemens Bros., of Woolwich, has a positive carbon electrode, A (Fig. 1), in the form of an inverted cylinder, the interior being filled with silicate cotton, B. Round the outside of the carbon cylinder is placed a paste, C, made up as follows:

	Per cent.
Manganese dioxide	25·54
Carbon	16 02
Silicate	12·76
Magnesia	12 88
Lime	0·96
Peroxide of iron	3·46
Moisture and ingredients not determined	28·38

Next comes a layer of white paste, D, of which the following is an analysis:

	Per cent.
Lime	26·18
Oxide of zinc	6·00
Magnesia	0·51
Ammonia	2 49
Water and binding material	64·82

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This forms a lining to the zinc cylinder, E, which is also the negative electrode. The whole is placed in a mill-board case, F, the space between the latter and the zinc being filled with sawdust packing, G. A stout wire is soldered to the zinc cylinder to form a terminal, and the carbon is also provided with a brass terminal screw and nut. A waste tube, H, is provided, and the whole is sealed with pitch, J.

The E.C.C. dry cell, which I shall next describe, is somewhat similar both in construction and the composition of the exciting pastes. It consists (Fig. 2) of a carbon plate, A, embedded in a black paste, B, made up as follows :

	Per cent.
Manganese dioxide	7·57
Carbon	47·26
Magnesia	7·20
Lime	1·40
Peroxide of iron	2·12
Ammonia	12 78
Water	9·77
Ingredients not determined	11·90

Next comes the white paste, C, as follows :

Lime	20 89
Ammonia	20·29
Chloride	6·31
Water and binding material	52 51

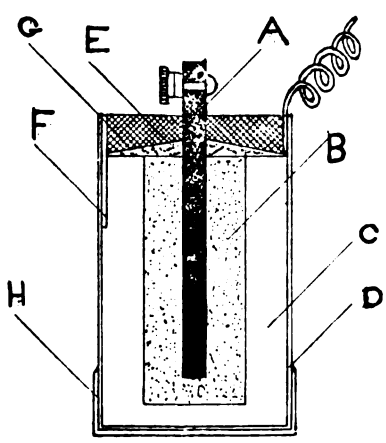

FIG. 2.

Then comes the zinc containing vessel, D, to which is soldered the usual wire connection. A thin layer of silicate cotton, E, is placed on the top, a waste-pipe, F, is provided, and the whole is then sealed, as before, with pitch, G. A terminal bolt and nut is introduced into the head of the carbon, and with the exception of an insulating base, H, the cell is complete.

It will be seen from these descriptions that the cells, though dry, contain a certain amount of liquid, which is, however, dissipated in the form of paste, thus rendering them for all practical purposes very convenient, as they can be placed in any position, and are portable. As a matter of fact, a true dry cell is an impossibility, as to produce a current in a primary battery there must be chemical reaction, and this is impossible in the absence of moisture.

The great drawback to this type of cell lies in the fact that they polarise very rapidly, and having no free liquid in their composition are unable to recoup themselves for some time. This renders them unsuitable for a current discharge of any intensity.

MUNICIPAL TELEPHONY.*

BY A. R. BENNETT.

The members of the Northern Society of Electrical Engineers have frequently had before them municipal projects for the supply of electric light and power, and the discussions which have taken place on these subjects have been of great interest and practical utility, but so far the society has not taken cognisance of telephones nor of telephone questions. I have therefore chosen telephones as the subject of the paper which I have been invited to contribute, particularly in their relation to municipal authorities.

In this country we have had no actual experience of municipal control of telephone systems, although Glasgow and several of the other Scottish towns are desirous of making a move in that direction ; but abroad things have been different, especially in Norway, where in one town of importance the telephone system has been owned and managed for the last six years exclusively by the Town Council ; while in Christiania the municipality has contributed to the capital of the local telephone company, and, being represented on its board by three town councillors, exerts a powerful influence on its management. These experiments have been so decisively successful that municipalities in other countries are taking steps to imitate them. Thus we find that the Town Council of Rotterdam is actually engaged in the construction of a telephone system of its own. The Rotterdam municipal exchange is to be opened in October, 1896 ; it is to be metallic circuit throughout, and the annual subscription is to be £6. 5s. 5d. for distances of five kilometres, or three English miles. The Town Council of Amsterdam has also resolved to build a new exchange, but neither the date of opening nor the subscription has yet been fixed. These facts have an important bearing on the present position of telephony in the United Kingdom. Our telephones are now controlled by two bodies only—the Post Office and the National Telephone Company. The exchanges possessed by the Post Office, with the one exception of Newcastle-on-Tyne, where there are some 600 subscribers, are quite insignificant, the Post Office subscribers in the United Kingdom not exceeding some 12 or 13 hundred in number. The Post Office exchanges, moreover, show no tendency to develop, many of them quite the contrary. Even Newcastle-on-Tyne has remained practically stationary for years, for the Post Office exchange in that town numbered 600 subscribers seven or eight years ago. The result is that the National Telephone Company is virtually invested with a monopoly, which, according to evidence given before the late Select Committee on the telephone service—evidence which is re-echoed from all parts of the United Kingdom—the company does not employ in a manner calculated to satisfy the reasonable requirements of the public. Independent companies have endeavoured from time to time to compete with the National Telephone Company, but always unsuccessfully, because this powerful corporation has invariably bought up its opponent regardless of cost—tactics which have been rendered successful solely by the support which it receives from the Post Office.

No person or company may construct telephone exchanges in this country without a license from the Post Office, and such licences have for several years past been withheld. The telephone patents under which the National Telephone Company for many years preserved its monopoly expired in 1891, and the public then looked forward, as a perusal of the Press articles of the period clearly shows, as it had a right to do, to competition as a means of bringing about a reduction of the heavy charges to which it was subjected, and of improving a service which was admitted by the company's own directors to be atrociously bad. But no sooner had the patents expired and the grasp acquired by the company on the country by their means loosened than the Post Office reinvested the company in its monopoly by refusing to grant any more licenses. The patent laws for 14 years enabled the company to defy all competitors, and when these laws ceased to be operative the Post Office stepped in and used the power which had been conferred on it by Parliament to confirm and extend the monopoly. The consequence is that telephonic charges in the United Kingdom are greatly in excess of those which prevail in most other countries, and approximate to double the figure at which they would stand if the earning of a fair dividend on the amount of capital invested in the construction of the exchanges were the accepted principle of the company's action. Unfortunately, even by the admission of the company itself, its capital consists to a large extent of "water" on which dividends have to be paid ; consequently the charges levied on the subscribers must be higher than would be the case if companies or other bodies, unhampered by surplus capital, were permitted to take a share in the supply of British exchange telephones. Before the late Select Committee the National Company admitted that its capital was watered to the extent of £1,292,000. This amount, in the opinion of some who have studied the subject, should be at least doubled ; but, accepting the company's own figures for the nonce, and likewise the statement that the company's lines numbered 73,338, it appears that £17. 11s. of "water" exists for each line owned by the National Company. Well, the late Dundee and District Telephone Company's lines cost £15 each ; the late Mutual Telephone Company's (double lines), £16. 16s. each ; the Christiania Telephone Company's, £12 each ; the Trondhjem Municipality's, £10. 2s. 6d. each. It is plain, therefore, on the National Company's own showing, that the "water" which exists for each line erected by the company exceeds the proper cost of the line, and that each line must stand in the company's books at much more than twice its actual cost. Such a state of things cannot exist without inflict-

* Paper read before the Northern Society of Electrical Engineers, November 11, 1895.

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ing grave injury on the telephone subscriber as an individual, and on the commercial interests of the country as a whole, yet it is a state of things that the late Government, through its Postmaster-General, did its best to justify, support, and perpetuate.

Unquestionably, to whatever cause the fact may be ascribed, the development of telephony in the United Kingdom has lagged behind that attained in many other countries. In a paper which I contributed to the British Association at its recent Ipswich meeting, I gave statistics which showed that the United Kingdom, the greatest home of industry in the world, ranked only tenth in the point of telephonic development amongst the European nations, and I sought to account for this unpleasant fact by comparing the conditions which exist here with those which have enabled nine other European countries to outstrip us. This state of things is a serious one for the British man of commerce. In Germany, Belgium, Norway, Sweden, Denmark, and other countries, we find a large proportion of the towns connected by trunk lines, so that the subscribers may call up their correspondents in all parts of the country. In many cases the trunk lines have now passed the boundaries of the different countries, and the merchants of several of the capitals and of the chief ports and centres of industry in the various states may communicate telephonically. I am, of course, aware that trunk lines exist in this country, and that communication has been established between London and Paris, but there is this important difference. On the Continent the charges made for the use of the trunk lines are extremely reasonable: thus, in Germany one can telephone all over the country for the sum of 1s. per three minutes; and even lower rates prevail in other countries. In the United Kingdom the charges are so heavy (and after the 1st of January next, when the Post Office will assume control of the trunk lines now worked by the National Telephone Company, they will be still further, in many cases, increased) that trunk line communication remains a luxury. No doubt the Post Office could point to a considerable telephonic traffic between London and Paris, and perhaps between London and Manchester, Liverpool and Glasgow. But an analysis of this traffic would probably show that the lines are not used as a rule by the commercial or manufacturing communities, but by stockbrokers for the purpose of buying and selling stocks. Communication between London and Paris is almost exclusively to this end, and, I believe, the same applies to the use which is made of the new trunk line between London and Glasgow. The fact is explained by the high rates charged, which stockbrokers can afford to pay and others cannot. Thus the curious circumstance is brought out that the public money voted by Parliament to the Post Office for the development of telephonic communication, is being devoted mainly to the benefit of one class, and that a class not generally esteemed the most reputable of the community.

Having briefly summarised the present position of telephones in the United Kingdom, I will ask the members of this society to accompany me in spirit to Norway and there ascertain what has been done by municipalities with the object of bringing home the telephone to every business man, and of allowing those who desire it the luxury of telephonic communication in their private houses. It may be remembered that the late Postmaster-General stated in the House of Commons that telephones in this country must always remain a facility to be enjoyed by the rich, and that even if by low rates a very large circle of subscribers could be obtained, the technical and engineering obstacles in the way of connecting them to an effective exchange were insuperable. Of course, no practical telephone man believes that, even in this country; and abroad the statement of Mr. Arnold Morley has created much amusement, for foreigners have in their own cities, and even in their own villages, proofs before their eyes that the statement is inaccurate.

I recently made a minute inspection of the telephone system of Trondhjem, which is the third town of Norway, and possesses about 30,000 inhabitants. The original telephone exchange was commenced in 1882 by a Mr. L. Spörck, who had obtained a concession from the Town Council. Mr. Spörck secured a considerable number of subscribers, which was not surprising, seeing that his charges amounted only to £2. 10s. per annum for a place of business and £1. 5s. per annum for a private house, rates which applied to distances not to exceed about an English mile. But the service given was not entirely satisfactory, and in 1889 the Town Council determined to purchase Mr. Spörck's system and thereafter manage the telephone business itself. Mr. Spörck having been paid the sum of £1,833 for all his rights, the Town Council proceeded to reconstruct his system in the most substantial and modern manner, a proceeding which, no doubt, provided a good telephone exchange, but which burdened the town with nearly £2,000 of superfluous capital at the start, inasmuch as the value of Spörck's material when taken down was so small that the purchase-money paid was not represented by any valuable asset. The capital expenditure, including the aforesaid purchase-money, now stands at £7,979, with which sum 780 exchanges and eight private lines have been constructed. The total number of lines being thus 788, it follows that each line has cost the town on an average £10. 2s. 6d. The population of the town being 30,000, there is one exchange telephone to each 38 inhabitants. In the United Kingdom the proportion is one in 636. The rates fixed by the Town Council were rather higher than those of Mr. Spörck, but are not, nevertheless, such as would be considered at all excessive in this country. They are as follows (per annum):

For a telephone exchange line connecting a place of business not exceeding 1½ kilometres (about one mile) from the central station	£3	6	7½
For a second business connection for the same person or firm	2	13	3
For a private house, not exceeding 1½ kilometres from the central station	1	13	4

Should lines exceed in length 1½ kilometres, these charges are increased by 5s. 6d. per annum for each 100 metres in excess. These charges include all payments. The Town Council supplies all the lines and instruments and maintains them. It is necessary to take particular note of this fact, because in some places in Norway and other countries subscribers buy their own instruments and pay the cost of their lines, circumstances which have sometimes been put forward as applying universally to all cheap Continental rates; but they are the exception, not the rule. At the middle of last October the value of the subscriptions on the books amounted to 38,300 kroner; and the number of exchange telephones being 780 the average revenue per telephone was 49·1 kroner, or £2. 14s. 4d. per annum.

The Town Council of Trondhjem consists of a burgomaster, 12 aldermen, and 36 councillors. The telephone business is managed by a telephone committee composed of two of the aldermen, one member of the committee being always a practical engineer. The committeemen retain their positions for four years, and are thus able to obtain a thorough grasp of the business. Acting under the committee is a manager and engineer who has qualified in the latter capacity in the Trondhjem Technical School, and acquired considerable telephonic experience in other Norwegian towns.

The capital is provided out of the rates, but interest at the rate of 4½ per cent. per annum is charged against the telephone system, so that the ratepayers not only lose nothing by the concern, but even make a good profit. It should here be mentioned that the tariff given above is subject to alteration by the Town Council if such a course should appear desirable, so that the income may be adjusted to the expenditure, and any increase of cost in working thrown upon the telephone subscribers, and not upon the ratepayers. It is, however, satisfactory to note that the tariff has sufficed hitherto not only to cover the working expenses, to provide interest on the capital, to create a reserve fund of 5 per cent. per annum on the capital expended, to ensure all the employés against death, accident, and sickness, but to leave a small surplus every year.

One of the many noticeable differences between Government, private, and municipal control of telephones is the fact that the German and other Continental Governments, like our own Post Office, render no accounts that outsiders can understand. The figures published do not distinguish between the telegraph and the telephone. Details of cost, salaries, etc., are carefully avoided, so that criticism is disarmed for want of material. Quite different is the procedure of the Continental telephone companies, whose accounts are models of precision and present all the necessary facts, together with the results obtained, in a plain and business-like manner. The Municipality of Trondhjem imitates this praiseworthy example, and, having nothing to conceal, sees no harm in taking the public entirely into its confidence. I am therefore able to place very exact details of the cost and results of the Trondhjem system before the society. Every year a budget or estimate of receipts and expenses for the ensuing year is prepared for, and sanctioned by, the Town Council. The following return shows in the first column the budget for 1894, and in the second column the results actually obtained for that year. The third column shows the items on which the budget estimate was exceeded, and the fourth those which failed to come up to the estimated figures.

COMPARISON OF THE BUDGET FOR 1894 WITH THE RESULTS ACTUALLY OBTAINED.—One krone = 1s. 1¼d.; 18 kroner = £1.

Receipts

—	Budget estimate.	Actual accounts	Excess over budget.	Under budget.
	Kr.	Kr.	Kr.	Kr.
Subscriptions received	34,307 00	34,320·51	14 51	—
Trunk-line fees	—	153 65	153·65	—
Sundry receipts	593 00	1,032 10	439·10	—
Kroner	34,900·00	35,507·26	607·26	—

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Expenditure.

Interest on capital and depreciation	12,471·39	11,439·83	921·56	—
Salaries	15,612·00	14,873·01	738·99	—
Law expenses	600·00	640·35	—	40·35
Rent	1,000·00	1,000·00	—	—
Cleaning	170·00	170·36	—	0·36
Office requisites and printing	600·00	1,035 50	—	435·50
Material for repairs	2,500·00	3,334·73	—	834 73
Bad debts	500 00	475 00	25·00	—
Insurance premiums	325·00	353 80	—	28·80
Sundry expenses	521·61	877·57	—	335·96
Kroner	34,300·00	34,310·15	1,685·55	1,695·70

It will be seen that the estimated receipts were exceeded by 607·26 kroner, whereas the estimated expenses were only increased by 10·15 kroner.

The next table is the budget estimate, in greater detail for the current year, 1895, with its principal items converted into English money.

BUDGET FOR 1895.

Receipts.

First half-year:			
481 subscriptions at Kr. 30	(£1 13 3)	Kr. 14430·00	
192 ,, ,, Kr. 15	(£0 16 7)	Kr. 2880·00	
40 ,, ,, Kr. 24	(£1 6 7½)	Kr. 960 00	
Second half-year:			Kr. 18270·00
491 subscriptions at Kr. 30	(£1 13 3)	Kr. 14730·00	
202 ,, ,, Kr. 15	(£0 16 7)	Kr. 3030·00	
40 ,, ,, Kr. 24	(£1 6 7½)	Kr. 960·00	
			Kr. 18720·00
Excess subscriptions for extra distances	(£38 17 8)		700 00
Trunk-line fees	(£27 15 6)		500·00
Receipts from four public stations	(£3 17 8)		70·00
Sundry receipts	(£30 0 0)		540·00
			Kr. 38800·00
			(£2,155 11 0)

Expenditure.

Interest at 4½ per cent on	Kr. 143,636·33	Kr. 6463·63	(£359)
Depreciation at 5 per cent. on	ditto	7181·82	(£399)
Salaries and wages:			13645·45
Manager and engineer	(£150 per yr.)	2700·00	
Storekeeper and clerk	(£66 13 3 per yr.)	1200 00	
Lady superintendent	(£3 6 8 per mo.)	720 00	
6 girl operators at Kr. 600·00	(£2 15 5½ per mo.)	3600·00	
7 girl operators at Kr. 480 00	(£2 4 5 per mo.)	3360 00	
1 reserve operator 9 mos. at Kr. 40	(ditto)	360·00	
1 ,, ,, 6 ,, at Kr. 40	(ditto)	240 00	
5 linemen at Kr. 780·00	(£43 6 8 per yr.)	3900 00	
Allowance to foreman	(£6 13 3 per yr.)	120·00	
Messenger	(£23 6 8 per yr.)	420·00	
Sundries:			16620·00
Reserve operators for emergencies, retaining fees	(£33 6 8)		600 00
Light and firing	(55 11 0)		1000·00
Cleaning	(9 8 10)		170 00
Stationery and printing	(33 6 8)		600·00
Materials for repairs	(138 17 8)		2500·00
Bad debts	(16 13 3)		300 00
Insurance premiums	(14 8 10)		260·00
Sundry expenses	(22 8 10)		404 55
			Kr. 36100 00
			(£2,005 11 0)

It will be seen that a profit of 2,700 kroner, or £150, was anticipated in the budget, but when in Trondhjem last month (October) I was assured that the estimate of receipts both for local subscriptions and trunk-line fees had been already more than realised. The estimate provides for an increase of only 45 subscribers for the whole year, whereas in October 84 had already been obtained, and the revenue stood at 38,300 kroner instead of the estimated 36,900. Instead of new orders ceasing with the growth of the exchange, as it was feared by some that they would, they are coming in faster than ever, and it is in contemplation to instal next year a multiple switchboard of the most modern type for the purpose of providing adequately for future business.

Having told you the terms on which telephony is supplied in Trondhjem, I shall now proceed to let you know what the subscribers obtain for their money. The subscribers are connected to the exchange chiefly by single aerial wires of phosphor bronze, but some have copper wires carried in suspended cables. Communication is obtainable at present only between the hours of 8 a.m. and 10 p.m., Sundays included, but the early establishment of an all-night service is contemplated. There are 11 towns in the neighbourhood of Trondhjem where exchanges exist, and with which trunk lines afford communication. These outlying exchanges are owned by local companies, not by the Trondhjem Municipality. The charge for speaking to them is 2d. for five minutes for subscribers, and 3½d. for non-subscribers. The most distant of these are: Hovin, 28½ miles; Stören, 31; Gosbak, 34¾; Svorkmo, 47½. It is thus possible to speak for five minutes over a trunk line 47½ miles long for 2d.

The Norwegian Post Office is also constructing for the use of the Trondhjem subscribers, and has nearly finished, two metallic circuit trunk lines through Levanger (43½ miles) to Stenkjær (68½ miles) in the North, which it is intended to subsequently extend to Namsos (105¾ miles). These lines are of 3mm. silicum bronze. The trunk line to Christiania (349¼ miles) is also to be commenced in 1896. The map before you will give you an idea of the actual telephonic network in communication with Trondhjem, as well as of the contemplated trunks. There is not at present any communication between the telephone system and the telegraph office, so that the subscribers are not able to forward telegrams from their own houses; but this defect is also to be remedied very shortly, the Town Council having promised to connect with the telegraph office whenever the Government desire it. Subscriptions are payable half-yearly in advance. The subscriber is only required to sign an agreement for six months, and can discontinue his line at any time by giving notice of that duration. When the subscriber shifts his office or his house, the cost of the labour of reconnecting him at the new place is charged, but the necessary material is provided free. The police and fire stations are connected, and special facilities are afforded for the calling of cabs, etc. The fire system of Trondhjem is very complete, there being no less than 28 electric fire-alarm stations scattered through the town and suburbs, worked by a central battery at the fire office. This fire-alarm system is managed by the telephone exchange, and the cost of maintaining it is borne by the telephonic budget, so that the telephone subscribers really support not only the telephonic exchange, but also the fire-alarm system. There are 10 public telephone stations in convenient localities, whence subscribers and non-subscribers can obtain communication with Trondhjem and the towns connected by trunk lines. Six of these public stations are situated in kiosks, primarily intended for the sale of newspapers, placed in the streets. The charge is 1½d. per five minutes for local and 3½d. for trunk talks. The fact that they are public telephone stations is indicated by the two telephones suspended from the dragon mouths on the roof. Why similar conveniences should not be provided at busy points in Manchester and other English towns is a problem which I will leave to the members of this society to solve—if they can.

It has sometimes been said in extenuation of the high charges in force in this country that the low rates on the Continent are possible because the construction work is badly done; that cheap material is used, and no efficient technical supervision provided. I have already had occasion to emphatically disagree with these assertions, as in my book on "The Telephone System of the Continent of Europe," I give several instances in which the cheapest rates coincide with the best workmanship and most modern material and apparatus. Trondhjem is another case of this nature. The rates are very low, as we have seen, and yet the workmanship and material is extremely good. The wire used is of phosphor bronze, 1·25mm. in diameter, being the same as generally used by the National Telephone Company in this country. Not only is the wire of the same nature and of the same gauge, but it is procured from the same makers, Messrs. Felten and Guilleaume, of Mulheim-on-the-Rhine. As Trondhjem is about 830 miles north of London, it follows that the freight incurred on the wire is very considerably in excess of that paid in England, so that the low rates in Trondhjem are certainly not attributable to the excessive cheapness of the wire used. This wire is supported principally upon iron structures, most of which are fixed on the house-tops, although some, as will be seen from the figures, are planted in the ground.

The subscribers are supplied with the beautiful instruments manufactured by the Norske Elektrisk Bureau of Christiania, a specimen of which is now before you. These cost £2. 12s. 2d. each, delivered free in Trondhjem, in lots of not less than 100, exclusive of battery. Such subscribers who desire it are supplied with instruments made by Messrs. L. M. Ericsson and Co., of Stockholm, the price of which is higher—viz., £2. 17s. 8d.—in lots of 100, delivered in Trondhjem. The Trondhjem instruments, therefore, cost more than those supplied to telephone subscribers in this country, while their workmanship is superior. The insulators used for supporting the wires are made at Porsgrund, in Norway, and cost 2d. each without the bolt. They are of a double-shed pattern. On some of the more crowded routes the subscribers' wires are led in suspended cables. Two of these cables contain 50 wires each, and are of the Pattinson type—that is to say, the wires are insulated with dessicated cotton saturated in paraffin wax, and protected by a heavy leaden tube. Others contain 25 wires, and are insulated with indiarubber protected by lead in the same way. These last cables were supplied by Felten and Guilleaume.

The working staff consists of five linemen, who work from 7 a.m. till 6 p.m., with one hour off for dinner. Their pay is £43. 6s. 8d. per annum, with an extra allowance of £6. 13s. 3d. to the oldest man, who acts as foreman. The Town Council

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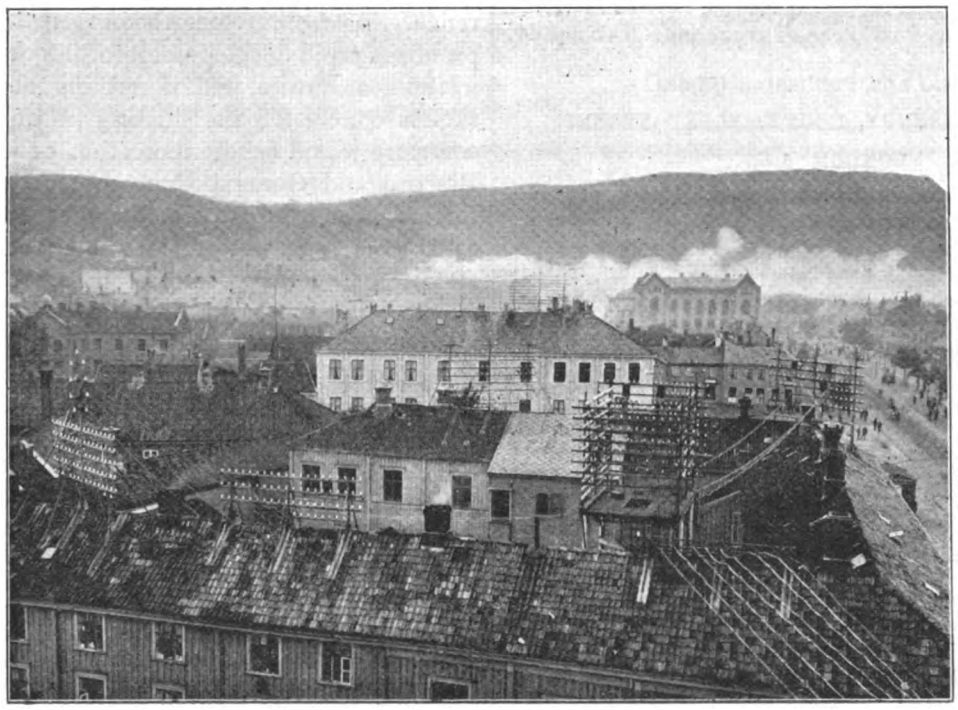
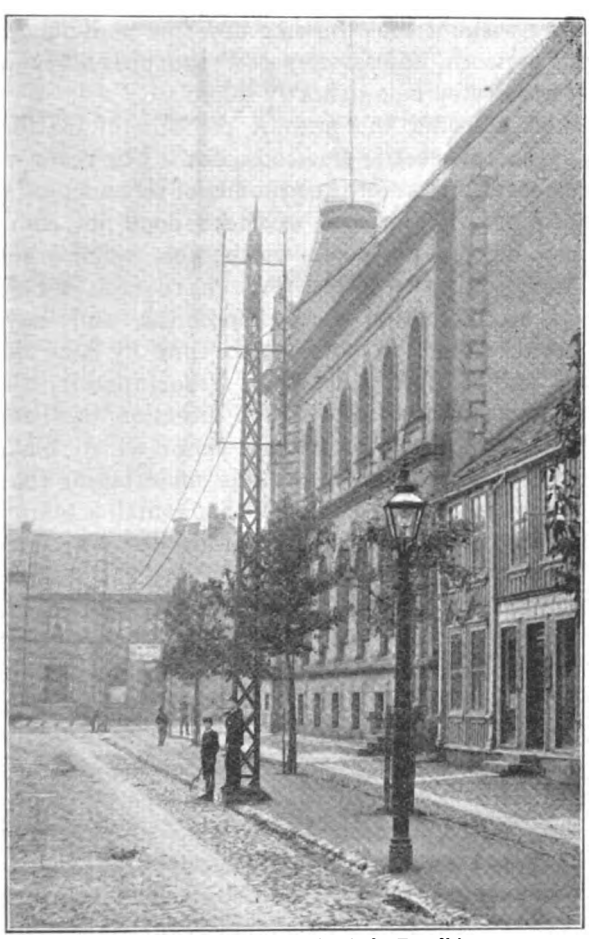
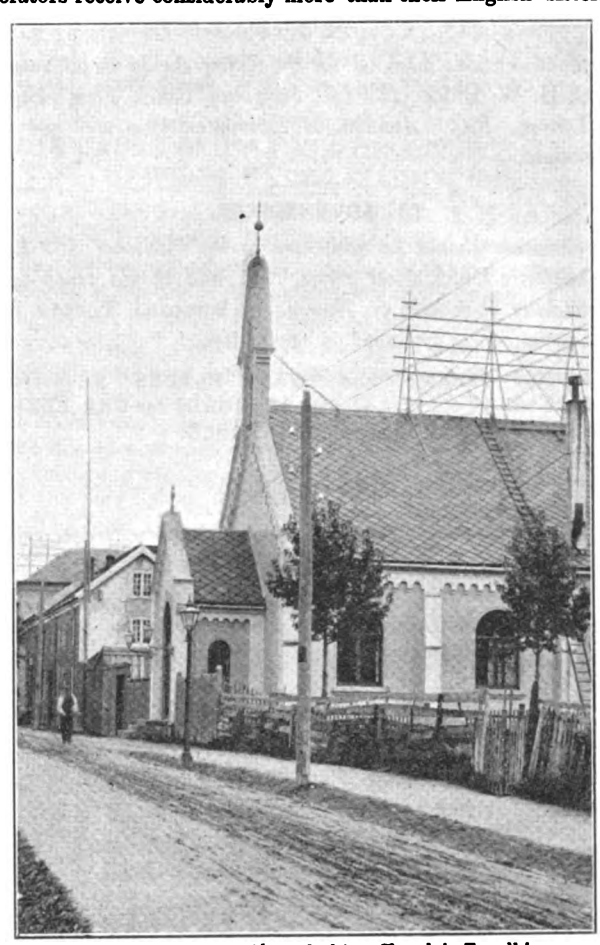
insures each man for £111 against death, and also for allowances in case of accident or sickness, the premium paid being 9s. 11½d. for each £55 of wages. Although the pay of these men may appear low, it is extremely doubtful whether that of the telephone linemen in any town of equal size (30,000 inhabitants) in the United Kingdom averages so much. The operating staff consists of young ladies, eight of whom, with the superintendent, are on duty at one time. At present their duties average a little less than 9½ hours per weekday, but as this is considered too long three new operators are about to be appointed. Their pay at present varies from £2. 4s. 5d. to £2, 15s. 5½d. per month, but the scale of wages sanctioned by the Town Council provides for an ultimate increase to £3. 6s. 7½d. per month. The pay of the lady superintendent is at present £40 per annum. In addition, there is a staff of reserve operators, consisting of young girls who have learnt the business, but who, pending vacancies on the permanent staff, are only called in on emergencies. They receive a small retaining fee, and are paid for work actually done at the rate of £2. 4s. 5d. per month. As each subscriber asks on the average from eight to nine connections per day, the girls have plenty to do during the busy hours. Each girl has 14 days' holiday per annum on full pay and is insured against sickness. It will be seen that, whatever may be thought of the workmen's wages, the lady operators receive considerably more than their English sisters.



The Trondhjem Municipal Telephone Exchange.—View showing the Central Station in Kongens Gade.



Iron Lattice Poles in Sondre Gade, Trondhjem.



View of 100-wire Standard attached to a Church in Trondhjem.

It is certainly a strange comment on the talk we have heard of the greater cost of telephonic work in this country to find that girl operators in Trondhjem are paid better than those of London, Manchester, or Glasgow.

(To be continued.)

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THE BRITISH ELECTRIC TRACTION (PIONEER) COMPANY.

Of late years the launching of electrical companies has been an operation of infrequent occurrence. A feeling has been growing up which promises rapid development in the way of traction in the near future, and if nothing more pointed to such a conclusion the floating of the above-named company would be an indication of the fact. The Electric and General Company, under whose ægis this pioneer company is brought out, is usually considered to be well in the know, and to be pretty certain of success before it puts its hand to the plough. The mere fact, then, that a pioneer company is projected means that its projectors see the way to do business. Before touching upon one or two of the problems presented by electric traction, and especially in its commercial aspect, it will be well to call attention to the fact that though the British Electric Traction Company is termed a pioneer company, its articles of association are broad enough to cover any expansion its directors may deem wise to undertake. So far as the prospectus is concerned, it says little, but infers much. It promises nothing; and yet we should imagine the company will become a handsome profit-earning concern, a prediction the more easy to prophesy when we consider by whom it is floated. "The profits of this pioneer company," says the prospectus, "will depend upon the successful issue of the capital of the larger company." Depend upon it, promoters would not go to the trouble of floating a pioneer company which is valueless without the "further step" as a dividend-paying concern, unless they saw the possibility of that further step being shortly taken.

Let us consider the present position of matters with regard to electric traction here. For years we have been urging it on the grounds of sentimentality and economy. The first of these does not count in business, but it has a marketable value when combined with the latter. We have always held that electric traction was economical, and have supported our views from time to time by facts and figures culled from practice. Unfortunately, the most successful practice in this direction has been in America, and causes existed there which made electric traction a more profitable undertaking than seemed to be possible here. Various small attempts have been made in Great Britain to introduce electric traction, but in almost every case the attempt has afforded no real criterion as to the true value of the system. In one place it serves for merely excursion traffic, in another its termini ended nowhere in particular, in another it was fettered by too great initial expense; in almost every case, indeed, the venture was something of an experimental one, and not such as would stand the best chance of paying its own way. The reason of all this is simple. The country was pretty well provided with tramways of one kind or another, few of which pay, most of which are, to say the least of it, injudiciously managed, none of which had any capital unexpended. Hence, even experimental lines could not be made under the best conditions. People are beginning to realise this, and to ask for something that shall be really on

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a practical commercial basis. Bristol and Dublin may perhaps serve in this direction. This is not enough. The existing tramways are mostly of a dead-and-alive character—dead as regards energy, as regards service, as regards accommodation; but unfortunately so far alive that they linger on to be a by-word and reproach to everybody concerned with them. Of course, we must admit that as there is no rule without exception, so a sweeping condemnation of this kind cannot be made to include every line. A few are really well managed—but a few is all we can admit to this distinction. What is wanted, and badly wanted, is to replace these moribund concerns by lines on which the service is frequent, where time is punctually kept, and where clean and commodious cars are provided. A proposition not understood by the present tramway management, is that the service and accommodation make the traffic, and not that the traffic warrants such-and-such a service. Our railways have found out this secret to success. The results are seen everywhere. The line that gives the best service is always the line which secures the greatest traffic. The business of to-day demands celerity, and the business of to-day will support celerity. The crawl to the South means a decided disinclination to travel in that direction, while the race to the North means that folks avail themselves of the facilities offered. What holds good on our railways and upon our ocean lines holds good for tramways, although the fact has not yet percolated down to the mediocre intelligences that seem to govern and paralyse most of the tramway lines. Is it possible with electric traction to give what is so urgently needed? If so, it is sure of success. The comparison of costs is absolutely useless to assist in determining the probable return. You may spend almost any initial sum you please upon a line, and the cost per car mile may be large or small. Whatever it be, if the return per car mile be above that cost, the total return will be large or small according to the total number of car miles run. Our interpretation of the articles of association and prospectus is that the company is fully alive to all these ideas, that it starts with a free hand, shackled to no system, but ready to adopt the best system demanded by the circumstances of each case. There is just one point whereon our views may not accord with those of a pioneer company. The municipalisation of tramways is not on the same footing as the municipalisation of electric light distribution. The latter we unhesitatingly advocate without any reservation; the former is not so great an article of faith, yet it may often be expedient. Even granting such expediency, the sphere of action is so large that neither this company nor any it might promote could hope to fill the field, and so, by providing the service required by the public, ought to have excellent chances of success.

Electric Lighting in Shanghai.—The *China Gazette* says the electrical department of the Municipal Council now runs 140 arc lamps, lighting some 15 miles of streets, and there are about 43 miles of line wire laid in addition to 6,100 incandescent lamps of 8 c.p. each for domestic purposes."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

EXPLANATION.

SIR,—Notices have appeared in your paper and elsewhere of a company styled the "British Electrical Manufacturing and Engineering Company, Limited," in the prospectus of which our name appears very prominently.

As this prospectus has been framed and issued to the public without our knowledge or consent, we shall be obliged if you will allow us space to explain the circumstances, as far as we know them, and to correct an inaccuracy, which is important to us and may be misleading to the public.

Finding that for our own work exclusively we could not advantageously run our brass-finishing works, and as it is not part of the business of electrical engineers to conduct works of this kind for the *sale* of brasswork, we determined to dispose of the machinery and stock in this department; accordingly we had agreed to sell them to the gentleman who appears as the vendor to the "British Electrical Manufacturing and Engineering Company, Limited."

We were expressly assured that no prospectus of any kind would be publicly issued, and as we feel that in the one which has come out, contrary to this assurance, much has been made of a concern which so far as our share in it goes is of very slender proportions, and our name is used appearing so that the public would naturally think we had authorised what is said, we wish to disclaim all responsibility for the announcement.

It is not true that we have undertaken to give the new company all our work. The fact is that we have engaged to give them our orders for similar goods to those which we have heretofore ourselves made at our works, provided that they can do them as well as to workmanship, price, and conditions as we can get them elsewhere.

There is, beyond these orders, no goodwill in the department, and the expression that the company has acquired the goodwill of our manufacturing department is very misleading.—Yours, etc.,

LAING, WHARTON, AND DOWN.

New Bond-street, W., November 11, 1895.

THE CAUSE OF CHANGE OF LENGTH IN IRON WIRES UNDER MAGNETISM.

SIR,—The experiments which Dr. L. J. Moore, of Johns Hopkins University, has conducted and communicated to the *Philosophical Magazine*, relative to the changes in length of iron wires under magnetism, are more especially interesting to me, because, when coupled with a series of experiments which I conducted some years ago, they prove the deductions which I was led to make and the theory which I then advanced as to the nature and cause of magnetism to have been quite correct—viz, that magnetic phenomena are due to a property which magnetic matter possesses by induction of causing polar phenomena by action and reaction at the pole points.

The most ready method, perhaps, of showing the reason of the changes in length of iron wires when they are magnetised will be to describe again the experiments to which I have alluded, and to restate and explain the theory which I deduced from them.

Taking two bars of steel, as equal in magnetic power as I could render them, I placed them together in every sort of position, and by watching the behaviour of fragments broken from the pointed ends of needles I examined and tested the lines of magnetic force in every instance. I thus proved (1) that the equator of bar magnets is always oblique (*vide Proceedings* of the Royal Society, April 24, 1879); (2) that the cause of the poles of a bar magnet not being situated respectively at its extreme ends, but at some little distance short of them, is due to the effect of lines of reactionary force which pass from the ends of the bar to meet those which come from the equator, the polar line marking the position where these forces collide and are ejected from the bar.

I will explain precisely how I arrived at this conclusion, because it has a most important bearing upon the cause of magnetism. When two similar poles of bar magnets of equal

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power were approximated, the needle points which had been placed upon the line of the magnetic pole of each bar gradually fell, and they could not be made to resume their more or less vertical direction until they were placed over the line of contact of the two bars. If the magnets were of unequal power, the polar line would be found on the stronger bar; and in proportion to the disparity of force between the two magnets, it would be at a greater or less distance from the bar end. The other positions assumed by the needle points as they approached the new polar line from either direction were identical with those which they took on a single bar magnet when moved in the direction of the polar line. On the other hand, when two dissimilar poles were placed together, almost all polar manifestations vanished, and the phenomena at the point of contact then tended to become like those at the equator of a single bar magnet; and they might be compared to the magnetic phenomena which are exhibited by a copper wire whilst conducting an electric current By these and other experiments I have satisfied myself that one of the distinguishing differences which exist between magnetic and diamagnetic matter resided in the property which magnetic matter possesses by the induction of reactionary force from the bar ends, of thereby throwing outwards from its poles the force which has traversed it in each direction—viz, from the equator to the poles and from the poles to the equator—a property which diamagnetic matter does not possess. In fact, the lines of force which are exhibited at the polar points are the counterpart of those which are shown by iron filings when two similar poles are approximated, only when these lines occur in the bar matter they are as permanent as are the phenomena of magnetic polarity, because the bar matter inherently possesses the power of thus dealing with the force or the stress which is acting upon it.

In this experiment of the approximation of similar poles of two bar magnets beneath a paper sprinkled with iron filings, we have a visible demonstration of the manner in which the polar phenomena are brought about. As the two similar poles are pushed from opposite points towards one another, the lines of force coming from either pole, as marked by the iron filings, are driven backwards and outwards by the corresponding lines of force coming from the opposite bar, until at length, when the bar ends touch, the phenomena are identical with those which are found to exist at and about the polar point of a magnet.

We are thus able to show why the changes of length determined with such accuracy by Dr. L. J. Moore occur:

1. When the oblique forces on the surface of a bar magnet meet with precisely similar oblique forces from the opposite direction, they tend to collide with them at a definite point—*i.e.*, the pole point, and to take a new direction—a direction which is the resultant of all the forces acting at the colliding point.

2. The primary effect of inducing magnetism in an iron bar or a wire is to cause a definite arrangement of the molecules, whereby their poles, in accordance with the character of their polarity, are made to point more or less north and south. Thus, the long axis of each molecule is placed parallel with the axis of the bar. And as this molecular arrangement commences from the equator and from the bar ends at the same time, the induction of magnetism in a bar tends to elongate the bar simultaneously from the poles to the equator, and from the equator to the poles.

3. As the forces approach each other from opposite points, in curved lines (the curves being equal) they collide and are thrown outwards, and the direction of the molecules is thus turned outwards to the surface of the bar, and shortening of the bar occurs.

4. The shortening of the bar would be in proportion to the intensity of the force and to the dimensions and purity of the bar matter, because certain definite relations must exist between the projection of force from the poles and the capacity of the bar matter for magnetism.

5. Any force in excess of that which gives definite arrangement to the molecules—*i.e.*, the magnetic capacity of the matter—must be productive of irregular molecular motion, diminution of polarity, and heat by molecular friction.—Yours, etc., R. C. SHETTLE, M.D.

Reading, November 7, 1895.

INSTITUTION OF CIVIL ENGINEERS.

The first meeting of the session 1895-96 was held on November 12, when a portion of the new building, comprising the theatre and approaches, with tearoom, etc., was made available for the purposes of the evening.

The chair was taken by Sir BENJAMIN BAKER, K.C.M.G., LL.D., F.R.S., the new president, who delivered his inaugural address. After some preliminary observations referring to the position of the institution in the domain of engineering, and the necessity of British engineers acting together in a true spirit of comradeship throughout the world, the president proceeded to discuss the question why engineering, unlike other liberal arts, was an essentially modern profession. Was it because the modern demand for rapid transit, often as purposeless as that of a record-breaking cyclist, had not its equivalent in the past, or was it because our ancestors lacked the inventive power and mechanical ingenuity of the present age? The artificers who built the highly ornamental barge in which Columbus blundered across the Atlantic could, with the same materials and workmanship, have constructed a clipper ship capable of sailing 300 miles in a day; but no one asked for speed in those days. On the other hand, although the present was pre-eminently an age of invention, an impartial survey of actions and events recorded in history would satisfy most people that in all ages there were to be found men no less intellectual and enterprising than ourselves. The general answer to the question raised would probably be that as it was only in the present century that people had insisted upon rapid locomotion by land and water, so it was the necessity of meeting that demand which had created the profession of modern engineering. When Watt directed his attention to the steam-engine, the country was weary of wars, and longed for the advancement of its material prosperity, and so a demand was created, and the country quickly became covered with canals, roads, and factories. At that time England depended largely upon her American colonies (now the United States) for the supply of iron, and in 1751 an Act was passed admitting American bar iron duty free to London, but prohibiting its cartage therefrom to Birmingham, as it was desired to make London, instead of Birmingham, the chief seat of the iron manufacture of the country. No one foresaw that Great Britain was to become the leading iron-producing country of the world. On all subjects, indeed, the most eminent men constantly failed in their forecasts. Smeaton did not believe in the steam-engine as proposed by Watt; Telford had grave doubts as to the practicability or usefulness of the Liverpool and Manchester Railway; Sir Robert Peel, 60 years ago, blocked a proposal in Parliament to make all the railways seeking access to London adopt a comprehensive plan for a central exchange station, so that through passengers and mails might be saved cabbing across London; Lord Brougham tried, in 1857, to make 30 miles an hour the statutory limit of speed on railways; Lord Palmerston told the House of Commons that the Suez Canal was one of those bubble schemes often set on foot to rob the English capitalist, and even Robert Stephenson, following him, declared it to be, commercially speaking, impracticable. All these mistakes, however, became insignificant when contrasted with the gigantic blunder, acquiesced in by the whole civilised world, of assuming, at the time of the Great Exhibition of 1851, that the efforts of the engineer would effect an immediate change in the long inherent savagery of mankind, thereby inaugurating a period of universal brotherhood and peace. Civil engineers were often reproached for devoting their ingenuity to the devising of man-killing appliances, but with little reason; for no one could fail to see that whatever might be the abstract principles of Christianity, in practical politics they were disregarded, it being always taken for granted that if a nation possessed that which another nation might covet, it must be prepared to defend its possession at the point of the sword.

It has been frequently assumed that everyone acknowledged the benefits conferred upon humanity by engineers in facilitating communication, cheapening production, and raising the condition of the toiler; but the late Prof. Froude

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had publicly stated that he failed to see much evidence of progress in the nature of men, and that "Even in the outward essentials of food and clothing and housing it is not certain that the mass of mankind in the present generation are better off than their forefathers." The president was not prepared to accept this dictum, and maintained, on the contrary, that the mass of mankind were much better off than their forefathers in these respects. Further, that the independence of the labourer and mechanic had been greatly advanced in consequence of the vastly increased demand upon their services due to engineering work. In support of this view, it was stated that as recently as four years after the opening of the Liverpool and Manchester Railway, certain Dorsetshire labourers ventured to erect themselves into an elementary form of trade union, and were sentenced to seven years' penal servitude for their pains. At the present time many municipal contracts provided for payment of wages at trade union rates, whereas a couple of centuries ago the magistrates fixed the rate at quarter sessions according to the price of food and clothing, the average being about 1s. a day for carpenters and masons, and 8d. for labourers. The hours of labour for all classes were from 5 a.m. till 8 p.m., with 2½ hours' interval for meals and rest. The penalty for an employer who departed from these regulations was 10 days' imprisoment and £5 fine, and for a workman 21 days' imprisonment. No man in search of work could beg without a license, the statutory penalty for a first offence being whipping at a cart's tail; while the second offence meant the loss of an ear and two days' scourging; and the third, hanging. On the whole, the study of the past was conclusive as to the material and moral progress which had accompanied the development of engineering works.

The president next dwelt upon the work done by physicists in the borderland of engineering, and expressed the opinion that long before the coalfields were exhausted some way would have been discovered of tapping the inconceivably great reservoirs of force in Nature still untouched. Although no one could foresee the demands of the next age, new wants constantly arose, and new branches of engineering often resulted from apparently trivial laboratory experiments.

In conclusion, the president sounded a note of warning against the growing disposition to overrate technical education. Education would do much, but it would not endow a man with common sense, nor would it make his opinion on a multitude of important subjects worth more than that of any naturally observant person. There were not wanting contractors and manufacturers who contended that some of the highly-trained young engineers of the present day were not wholly free from a tendency to overmuch reliance on formulas, without due regard to the sufficiency of the data upon which such formulas were based. Such faults were best remedied by joining in practical discussions with other engineers, such as it was a province of the Institution of Civil Engineers to encourage.

After the delivery of the address the president presented to the recipients or their representatives the medals and premiums awarded for papers presented last session.

THE ADVANCE OF THE ELECTRIC RAILWAY MOTOR.*

BY G. T. H.

No dynamo-electric machine has in so short a time been more radically changed and more efficiently improved than the electric railway motor. When it was demonstrated that it was possible and practicable to operate a street car by electricity, all of the large electrical manufacturing companies designed motors for this service; but it is never possible to break completely away from old ideas, and in no case has this tendency been more apparent than in the case of the electric railway motor. Modern practice has shown us how necessary were these radical changes. At the beginning of electric traction the electric motor which the manufacturers had already produced possessed the following characteristics: first, high speed; second, severe sparking at change of load; third, extreme susceptibility to dust and water; fourth, need of constant attention; fifth, weak torque or turning moment; sixth, great weight for power supply; seven, unsightly over-wound drum windings.

This motor when used for traction had to work under the following conditions: first, without any attention whatsoever; second, with water, dust, or mud present at all times; third, with severe starting torque; fourth, heavy changes of load at all times; fifth, constant vibration; sixth, no lubrication; seventh, operation under the care of an inexperienced man. Any two more incompatible states of conditions and requirements could not be devised. These adverse conditions are the same to-day as they were then, but the motor has been improved to meet them. Every part of a modern railway motor has been especially designed for the purpose, and has passed through a series of changes both interesting and instructive.

There are three important vital parts of an electric railway motor—the armature, the commutator, and the field magnet. Other important parts are the brushes, bearings, and the gears. Taking the armature first, the original type was taken directly from the stationary motors which were then manufactured with plain surface-wound rings and drums. The compact drum armature had many attractions, but the trouble from the over-wound heads gave the ring armature an advantage, as did also the fact that the greater relative distance of the movable wire from the axis gave greater torque and slower speed. It is a well-known fact that it is not possible to economically wind a bipolar drum armature whose length is not at least one and one-half times its diameter. Therefore, the drum armature, to approach the "over-all" diameter of a ring, would be excessively long, and of greater power than required. Still, this great advantage did not permit the ring armature to attain a single reduction of power any sooner than the drum. Both seemed to make the transition simultaneously. The ring armature had and still possesses the advantage that, in the event of sections burning out, they can be rewound without disturbing in any way their fellows. This is an advantage which is not claimed for any drum-wound armature now built. In the early days of electric motors the drum-wound armature had a mechanical advantage that was not to be underestimated. It was possible to secure the lamellar core of the drum armature upon the shaft in a much more rigid and mechanical manner than that of the ring. Summing up the case, the ring armature was preferable, but the persistent conservatism of many manufacturers of drum armatures and the radical improvements that have been made have done much to make the drum armature superior to the ring, in the eyes of many users.

Up to the time that electric motors came to be redesigned for street railway propulsion, the toothed armature was looked upon with great suspicion as liable to involve spark troubles of a most serious nature. However, the fact that a much lighter equipment would result from the use of toothed armatures caused expert designers carefully to study the problem and effectually solve it. Thereupon both the ring and drum armatures became toothed, and great economy in weight and magnetic power was thus effected. But this change to toothed armatures was a great advantage to the drum type. With surface-wound armatures it is a fact that unless at least two wires are wound in a section it is impossible to have the coils symmetrical, of the same shape and resistance and, at the same time, compact.

Compact, symmetrical windings for surface-wound armatures existed before electric railroading, but for some reason they were never generally adopted. The teeth between the wires on the drum armature give sufficient room to connect the conductors either in a spiral path in the plane of the head of the armature, or diagonally on the cylindrical surface of the armature produced. Two layers of wires are all that are required, and each connector has its path partly on the upper and partly on the lower layer. Each coil may now be machine formed, and identical in shape with its mates. They pack closely into the space provided for them, each one having just room enough and no more.

* *Electric Railway Gazette.*

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Thus they mechanically lock each other in position, and form a well-insulated structure, as it is possible to insulate the coil separately before slipping it on to the core. In the event of a coil being injured or burned, by slipping off a few coils the injured one can be removed or replaced, while the uninjured coils that were removed are not in consequence destroyed, as was the case with the old over-wound drums.

The time employed in placing the coils on the core is but a few hours, and many companies now claim that two of their armatures of this type can be completed, as far as winding and connecting is concerned, in one day and by one man. This gives the drum armature prestige over the ring where the ring was formerly superior.

The advent of the multipolar fields facilitates the use of separate coils to even a greater extent, for no rigid rule as to length and diameter need be adopted to secure an economical winding. The present standard motor for street car propulsion has a toothed multipolar drum armature wound with machine-formed coils. It is the product of successive ideas and their application, and is meeting with deserved success.

It has seemed singular that the present iron-clad motor did not sooner come into general use, as iron-clad machines existed before electric railroading, in the inventions of Eickemeyer and others. Nevertheless, manufacturers seemed to prefer to use their own distinctive types, whether they were suited for the purpose or not. The reason is partly to be found in the convincing force of the oft-repeated statements of each maker that his special type is the only rational and practical form suitable for any service, and partly in the maker's desire to exercise an economy by the use of existing patterns and calculations, even though that economy be a false one. Therefore, these makers took one of their existing frames that had given good service as a motor, and redesigned it for service under a car. Lugs and arms were cast on to the frame, the brushes rigidly fixed, the field magnet series wound, and thus equipped it was sent out for active service. As everyone remembers, it did not accomplish its mission. It came back to the shop in a few weeks incrusted with dust and mud, with both armature and magnets disabled. The motor was laboriously dismantled, its magnets were removed and rewound, so that it soon became apparent that the use of movable coils for field magnets would greatly facilitate repairs. The motor was then put together and provided with an elaborate enclosure made of sheet iron and rubber cloth, which added to the weight of the equipment. However, this state of things was not to last.

The obstacles that had been met with were very discouraging, and it was clear to everyone that a new type of field magnet was necessary. First, the motor must be constructed in such a way that it could be more easily taken apart for repairs; second, it must be protected from dust and mud; and third, it must be lighter. The first of these requirements was found in a motor of the hinged type that could be readily opened when repairs were necessary. The second problem was more slow in solution, but eventually was perfectly solved with the development of the iron-clad type of motor. In this type the motor becomes its own dust-proof enclosure.

In the meantime the electrical side of the question had not been neglected. Soft steel enabled designers to produce a motor with an intense magnetic field. This gave a slow speed and starting torque sufficient for a single reduction of speed. Then it was that several too sanguine inventors overshot the mark and produced a gearless motor. Not that the gearless motor was by any means a failure, but the particular interurban and long-distance service that it is fitted for was not then demanded, and the motor proved to be a failure in small sizes and in crowded sections. The boom of the gearless motor, therefore, subsided, and anything of that type is always suspiciously regarded by street railway officials. However, the single-reduction motor was received with great favour, and has become the standard among all street railway companies. Manufacturers differ in methods of connection and the number of coils they use to obtain the multipolar field, but they are unanimous in adopting multipolar types. The street railway motor has now reached such a state of perfection with regard to its windings that it would be difficult to imagine an accident to it that would involve more than a day's work for two men.

Rapid and radical as the changes have been with armature and field magnet, the commutator, which, after all, takes a very heavy duty of the machine, has been but little improved. In one way this is not the designer's fault. Mechanically, nothing could be better than the rigidly-built commutator now in use on railway motors. The bars are drop-forged, the mica insulation is of the best, and the whole is solidly clamped together under enormous preseure, yet it is well known that a commutator on a railway motor is of very short life. Dust has been effectually excluded from the commutator, but the evil of sparking is still there, and will continue to gnaw the commutator away until it is cured. Sparking on an ordinary railway motor of good design and otherwise in perfect condition results from two causes: first, dirt on the commutator; and second, improper position of the brushes. The proper position of the brushes is on the neutral line which fluctuates back and forth with the work the motor is doing. Either this fluctuation must be stopped by some method of winding which will counteract the armature reaction, or else the brushes must be moved to follow it. Neither has been done. The modern well-designed street railway motor has quite a wide non-sparking zone, but the dirt which will inevitably collect is sure to aggravate sparking, thus narrowing the zone, and unless the brush is in exactly a non-sparking position the commutator will be worn away. Inventors have suggested methods for making the neutral line stationary, but this does not seem to have met with popular approval. Common practice is to clamp the brushes firmly in the position which is found to be the best average, and the commutator is removed if required. Perfection for traction motors cannot be claimed until a machine is produced that shall have long and equal life in all its parts.

The sweep that the brushes of a railway commutator take in exactly following the neutral line in its fluctuations is much larger than on any dynamo or stationary motor, because of the fact that the motor is required to reverse. If there were absolutely no armature reaction there would be no shifting of the neutral line, which would then be situate exactly between the pole-tips, provided that no lead had been given to the armature connections. As it is, the conditions are as follow: When the motor rotates, say, in a right-hand direction, the neutral line rotates in a reverse direction, and the greater the load the further it extends. When the motor is reversed, the direction of the neutral line also reverses, and is entirely on the other side of the position that it assumes at no load. Therefore, a street railway motor or any motor which runs as much in one direction as the other, should have twice the range of brush adjustment which would be necessary if its direction of rotation was uniformly the same. There is urgent need of action on this matter, for at present the case is of the worst possible description, and is costing yearly many thousands of dollars. Street railway practice at present dare not risk the complications of a brush-adjusting device attached to the controller spindle. It would be well to consider the advisability of two non-sparking positions, one for forward and one for reverse motion, to be operated when reversing the car for the return trip. The commutator is, and for some time to come will be, the weakest part of a railway equipment, until some day our hopes are realised and the induction motor will propel railway cars.

CARBORUNDUM AT NIAGARA FALLS.

As we have already announced, on October 19 one of the furnaces of the Carborundum Company was put in operation, the electric current being obtained from the Cataract Company's power-house. A 2,200-volt current comes into the carborundum factory, which current is transformed into one of 7,000 amperes at a pressure of 185 volts. The transformer in which this conversion takes place is said to be the largest in the world. The

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furnaces in which carborundum is made are built of brick, and are each about 15ft. long, 7ft. wide, and 6ft. high. In the centre of each end wall of the furnace is a large bronze plate, to which are connected four large copper cables, carrying the current from the transformer to the furnace. Connected to each of the bronze plates are 60 carbon rods, each about 2ft. long and 3in. in diameter. These rods, which project through the walls, form the terminals of the conductors. The furnace is charged with the proper substance (sand, salt, coke, and sawdust), and through the centre of the mixture a core formed of fine grains of coke is built up, which serves as a conductor of high resistance between the terminals. When the current is turned on, it raises the contents of the furnace to an enormously high temperature, at which the chemical change that produces carborundum takes place.

WHAT, WHEN, AND WHERE.

Institution of Electrical Engineers.

November 28.—"The Electric Wiring Question," by F. Bathurst. "Concentric Wiring," by Sam Mavor.

Institution of Civil Engineers.

November 19, 8 p.m.—"The City and South London Railway, with Some Remarks upon Subaqueous Tunnelling by Shield and Compressed Air," by J. H. Greathead.

Physical Society.

November 22.—1. An exhibition of photographs of spectra by G. Johnstone Stoney. 2. "A Direct-Reading Platinum Thermometer," by R. Coppleyard. 3. "Historical Note on Resistance and its Change with Temperature," by R. Coppleyard.

Institution of Junior Engineers.

November 16, 3 p.m.—Visit to Messrs. Bell's asbestos works, Southwark-street, London.

Society of Arts, John-street, Adelphi, London, W.C.

November 20, 8 p.m.—First ordinary meeting. Opening address of the 142nd session by Major-General Sir John Donnelly, K.C.B., chairman of the council.

Royal Meteorological Society.

November 20, 7.30 p.m.—At the Institution of Civil Engineers, 25, Great George-street, Westminster, S.W. Ordinary meeting. "On the Origin of the Cold Weather Storms in the Year 1893 in India, and the Character of the Air Movement on the Indian Seas and the Equatorial Belt, more especially during the South-west Monsoon Period," by John Eliot, M.A., F.R.S., F.R Met.Soc. "The Diurnal Variation of Wind Velocity at Tokio, Japan," by Charles Davison, M.A., F.G.S. During the evening W. H. Dines, B.A., F.R.Met Soc., will show his experiment illustrating the Formation of the Tornado Cloud.

North-East Coast Institution of Engineers and Shipbuilders.

November 16, 6 p.m.—At the Athenæum, Church-street, West Hartlepool. Second general meeting of the session. 1. Minutes of last general meeting. 2. Ballot for new members. 3. "The Application of the Law of Similarity of Marine Propellers," by J. Denholm Young. 4. Discussion.

November 16.—The graduate members visit the Central Marine Engine Works, West Hartlepool.

December 17.—At the Lecture Hall of the Sunderland Literary Society, Fawcett street, Sunderland. Third General Meeting. "An Investigation into the Forces tending to Produce Vibration in High-Speed Engines," by J. M. Allan.

ST. PANCRAS LIGHTING SCHEME.

The following is the report of Mr. Sydney W. Baynes, chief electrical engineer to the Electricity and Public Lighting Committee of the St. Pancras Vestry, respecting increased voltage for distribution of current:

Pursuant with instructions, I beg to submit the following report setting forth the advantages to be had by the employment of higher voltage for the distribution of electricity from central stations.

In 1877 the first incandescent Swan lamp was produced, but it was not a commercial article in the sense we now know the incandescent lamp, because its voltage was too low, being only 50, and therefore worthless for central-station distribution. In 1881 Edison inaugurated his central-station system with lamps of 100 volts, and in consequence the Swan Company were compelled to manufacture their lamps at double the original voltage. This gave considerable impetus to the electrical industry, being quickly followed by the establishment of central supply stations throughout the country. At this present date the old 50-volt lamp is obsolete, and a number of first-class lampmakers are producing lamps of 8 c.p., 16 c.p., and 32 c.p. and upwards at various voltages up to 250.

When I first introduced the higher-voltage movement, some two years ago, I had numerous enquiries from American engineers as to the success of the scheme. While in England we creep slowly on our American friends push boldly forward, and the change there is making rapid progress, especially in the Edison stations. Edison has expressed himself to the effect that a higher-voltage direct supply is the system of the future.

When commencing my duties in St. Pancras I found that a number of premises had been wired ready for connection to the mains from the King's-road station, and I learned that no instructions had been issued to the wiring contractors as to the subdivision of the circuits so as to enable a supply to be given on a five-wire system. Experience elsewhere has shown that no service line should carry more than 10 to 15 amperes, and it has become the rule to run the five services into the majority of the houses; in this way a potential difference of 440 volts frequently exists in the buildings, but so far no trouble has been experienced by the consumers from this cause.

Our customers having their premises already wired could not readily comply with the requirements consonant with the five-wire system, neither could we call upon them to rearrange their wiring, but we could supply them with increased voltage which would only need two service lines and suit the arrangements already made.

A further advantage is the saving in the cost of house services. The average cost of coupling up a customer with lead-covered cables amounts to about £6 where a two-wire supply is given; each additional wire, including its main switch and cut-out, may be estimated to cost about £2, so that where a five-wire supply is needed each house will cost £12 for service lines. Should a customer demand a day and night supply, the expense and complications involved would render such an arrangement clumsy and impracticable On a 220 volt supply these difficulties would not be met with, as only a two-wire service would be necessary.

The royalty claimed by the Westinghouse Company for the use of Hopkinson's patent had also to be dealt with. It transpired during correspondence on this question that the money paid on the Stanhope-street mains did not cover the use of a five wire system over the area supplied by the existing mains and the company stated that had this been contemplated their charges would have been in the neighbourhood of £28 per ton of copper laid, instead of the £11 per ton they had received.

Had we connected our five-wire extensions to the old system and run the two together a further payment of some two or three thousand pounds would probably have been demanded. I am able to speak with some authority on this point from past experience with this company, where a parallel case had to be dealt with, and finally payment was enforced.

In the original estimate for the King's-road works the royalty was set down at £1,200, but this was based on a three-wire agreement. Taking it at £28 per ton, as intimated by the company for a five-wire agreement, it would amount to close on £3,000, or a total additional payment over the old and new works of some £5,000. In order to deal with the question in an effectual and diplomatic manner, and having regard to other advantages herein stated, the circular of September 1, 1895, was issued to the wiring firms, intimating the introduction of an increased voltage. The company know full well the advantage of the high voltage, and that by its introduction we could do more for our Stanhope-street mains than by a conversion into a five-wire system, and further that we could meet all present demands on the King's-road works by the employment of this voltage on a two wire system, free from royalty. Consequently, we have been able to secure the privilege of using any multiple-wire system on our Stanhope-street mains, or any extension thereof, without increased royalties, and the charges on the King's-road mains have been reduced to a lump sum of £750 on 110 tons of copper laid. If the circular of September 1, 1895 never effects more than this, it has done excellent service. I hope to show, however, as briefly as possible, that the advantages to be derived from the use of the higher voltage have a very important bearing on the future of electric lighting.

A station delivering current at 220 volts to the lamps will possess the following advantages over that delivering at half the pressure. With the same expenditure in copper we can do four times the lighting on the mains, or the same amount of lighting at four times the distance with the same percentage loss; consequently the area that may be covered by the higher-volt station is 16 times greater than that of the low.

The lighting from the low voltage is unsatisfactory, because of the excessive fall of pressure along the distributing mains and in consumers' premises. This is very difficult to remedy, being almost unavoidable without extravagant use of copper. Frequently a fall of 2½ volts occurs in the consumer's wiring, reducing the light given out by his lamps by 13 per cent. If the voltage were increased to 220, the variation in the lighting would be so slight as to be inappreciable.

The increased copper on a five-wire system at 110 volts compared with a three-wire at 220 volts is about 50 per cent., so that in extending mains from the King's-road system only three mains are needed; hence a considerable saving in capital will be effected.

No further transformer sub-stations will be required, a point which alone tends considerably towards economy both in working

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costs and upkeep. Moreover, it is undesirable to have either machinery or battery stations at numerous points throughout the parish, as all apparatus of the kind requires constant attention.

In regard to the Stanhope-street mains, from numerous complaints received, it is evident the old mains in several districts are overtaxed, although not 50 per cent. of the customers along the route have been dealt with. Whether we now augment these mains by the increased voltage, or convert them into a five-wire arrangement, the risk of breakdown to earth, both on the consumers' premises and on the mains, is unaltered. If the 220-volt system is introduced, we may either increase the capacity of these mains fourfold, with the same percentage loss, or twofold, with half the percentage loss.

With the increased voltage the plant used for lighting will be identical with that for electric traction, therefore our plant would afford excellent facilities for combining lighting with electric traction throughout the parish, no extra generating plant being required.

Any modification which will effect a saving, either in the production of current or in its distribution, must ultimately benefit the ratepayer and consumer alike.

The increased voltage to consumers' premises does not in any way at the present stage infringe the requirements of the provisional order, because we read, Section 27 (*e*), "the standard pressure may be different for different points of any main," etc., "but it shall in all cases be within the limits following."

The limits are in the case of continuous current not less than 30 volts nor more than 300 volts. [The original order only allowed up to 200 volts, but was increased by the Board of Trade to 300 volts in November, 1890]

(*d*) "The 'standard pressure' shall be fixed by the undertakers for every main, and shall not be altered except after notice to the Board of Trade," etc.

The standard pressure on our mains is unaltered, and it is not intended to vary it at the present stage, neither will the old customers' voltage be changed without following the instructions contained in Section 27 (*d*).

PHYSICAL SOCIETY.

At the ordinary meeting of this society held on the 8th inst., Prof. A. W. Rücker, vice-president, in the chair,

Mr. W H. Everett read a paper on "**The Magnetic Field of any Cylindrical Coil or Plane Circuit.**" The method of treatment is based on the formula for the force due to an element of current. A single integration applied to one component of this force gives for any point in the field due to a plane circuit the force perpendicular to its plane, and a double integration gives the longitudinal force at any point due to a cylindrical coil of any cross-section, the depth of winding being supposed inconsiderable. For coils in which the latter condition does not hold, an approximate solution can readily be found. The force parallel to the plane of a circuit and the transverse force due to a coil are investigated in a similar manner. The general results are of a very simple form, and admit of easy approximate calculation. Special formulæ are deduced for coils of rectangular cross-section, the general expressions being in this case integrable Appended to the paper are some numerical results giving the values of the forces at different points due to coils of various dimensions.

Prof. Perry said he considered the paper to be a valuable one, particularly as illustrating a practical mathematical method of integrating.

Mr. Trotter said the paper was of interest to him, as he considered that several of the author's results might be applied to the solution of problems on illumination, *e.g.*, the illumination of a room by a circle of lamps.

Mr. Rhodes regretted that it had not been possible to supply a proof of the paper before the meeting. The method, in which the author obtained the force outside a solenoid as the difference of the forces due to two solenoids, reminded him of the method employed in calculating the attraction of, say, a truncated pyramid.

Prof. Silvanus Thompson said the author had mentioned several previous papers on the subject, but had not referred to one by Prof. Viriamu Jones, in which the force due to a solenoid is obtained in terms of elliptic integrals. Another method of attack was to calculate the work done when a unit pole is carried through the solenoid and back outside to the starting point.

Prof. Ayrton said he also regretted the absence of a proof of the paper. He considered it of great importance to have exact and simple methods of calculating the forces due to a solenoid.

The **Chairman** (Prof. Rücker) said he had made a somewhat similar calculation in connection with the magnetic effect of sheets of basalt below the surface of the earth.

Mr. E. H. Griffiths read a paper by himself and **Miss Dorothy Marshall** on the "**Latent Heat of Evaporation of Benzene.**" The method employed is similar to that used by one of the authors in the determination of the latent heat of evaporation of water (*Phil. Trans.*, 1895). The loss of heat due to the evaporation is balanced by (*a*) the heat supplied by an electric current; (*b*) a secondary supply due to the work done by the stirrer; (*c*) a slight gain or loss due to small unavoidable changes in temperature of the calorimeter. The comparative values of the various sources of heat (if we denote the supply due to the electrical current by 1,000) is approximately: electrical = 1,000; stirring = 11; changes in calorimeter temperature ± 5. The electrical supply could be measured with extreme accuracy, and the above table shows that small errors in the determination of the remaining thermal quantities are of little importance. The results may be summed up in the formula

$$L = 107{\cdot}05 - 0{\cdot}1581\,\theta,$$

where θ is the temperature and the thermal unit at 15deg. C is used.

The discussion on this paper was postponed till after the reading of the paper by **Prof. Ramsay** and **Miss Marshall** on "**A Method of Comparing the Heats of Evaporation of Different Liquids at their Boiling Points.**" The method employed has already been described before the society (January 11, 1895). The liquid to be experimented on is put into a glass bulb enclosed in an outer jacket filled with the vapour of the same liquid. An open tube is attached to the top of the bulb, so that there is free communication between the interior and the vapour jacket and no loss of material. Inside the bulb is a spiral of fine platinum wire, attached to stout platinum terminals, which are sealed into the glass. The temperature of the liquid in the bulb is raised to the boiling point by the vapour jacket; thus when a current is sent through the wire the whole of the heat developed is spent in converting a portion of the liquid into vapour. Two such bulbs are connected in series, and the ratio of their losses of weight is the inverse ratio of the heats of evaporation of the liquids. A correction is made for the inequality in resistance of the spirals, and the ratio of the differences of potential between the ends of the spirals, when the current is passing, is determined in each experiment by Poggendorff's method. Results are given for 14 liquids.

Prof Ramsay drew special attention to the table giving the values of the quotient, $\frac{ML}{T}$, where M is the molecular weight, T the absolute temperature, and L the latent heat. Very curious differences are noticeable in the case of water, alcohol, and acetic acid.

Prof. Carey Foster expressed his admiration for the method, since it obviated the necessity of knowing the specific heat of the liquid or vapour.

Prof. Silvanus Thompson said the difficulty experienced in the case of water due to electrolysis might be obviated by the employment of a spiral of lower resistance and a larger current, so that the difference of potential between the ends of the spiral should be less than 1 7 volts.

The **Chairman** said Captain Abney had asked him to enquire to what extent the temperature of the liquid was affected by radiation.

Mr. J. W. Rodger asked if any direct experiment had been made to determine if the temperature of the liquid was not above its true boiling point. In some cases differences of as much as 2deg. might exist between the temperature of the liquid and that of the vapour given off. The differences in the value of $\frac{ML}{T}$ in the case of water, alcohol, and acetic acid might be due to the fact that the vapours of alcohol and water were simple, while the vapour of acetic acid was complex.

Mr. R. Appleyard suggested that the differences obtained in the case of water might be due to the presence of dissolved air.

Mr. Griffiths said that the objection to the adoption of Prof. Thompson's suggestion was the fear that with short wires an excessive difference in temperature between the wire and the liquid might exist.

Mr. Rhodes asked if Mr. Griffiths could trust his determinations of temperature to the 80,000th of a degree?

Mr. Griffiths, in reply, said that he thought there was no limit to the accuracy with which a difference of temperature could be measured. The absolute temperature, however, he only relied upon to $\frac{1}{1000}$th of a degree.

Prof. Ramsay said the fact of superheating existing would not affect the results, since near the temperatures at which they were working the latent heat did not vary appreciably with the temperature. In reply to Captain Abney, he said some previous experiments by Dr. Young and himself had shown that the vapour jacket was quite impervious to radiant heat from without.

LEGAL INTELLIGENCE.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY v. EBBSMITH.

On Monday last, in the Court of Appeal, consisting of the Master of the Rolls and Lord Justice Kay, the appeal of the plaintiffs from an order at Chambers of Mr. Justice Hawkins was decided. The appeal had been postponed from Monday, 4th inst., under circumstances reported in our last issue. The plaintiffs alleged in their statement of claim that Ebbsmith was the promoter and solicitor of the South Staffordshire and Birmingham District Steam Tramways Company, Limited, which was taken over by the plaintiff company, and that while occupying that fiduciary position he formed a company called the Dickinson Tramway Appliance Company, Limited, which company was a sham, being, in fact, Ebbsmith himself; that certain patents were bought up for small sums by Ebbsmith and assigned by him to the Dickinson Company; and that Ebbsmith then procured the plaintiff company and their predecessors to purchase articles, the subject-matter of the patents, and licenses to use the patents at exorbitant prices and without any disclosure of his interest in the patents. The plaintiffs claimed damages, an account of the defendant's profits, and a rescission of the plaintiffs' contracts as to the patents. On the application of the plaintiffs, the Master made an order under the Bankers' Books Evidence Act, 1879, that the

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plaintiffs should be at liberty to inspect at the Metropolitan Bank, Limited, the books of the Staffordshire Joint-Stock Bank, Limited, and their successors for the years 1885 to 1894 containing entries of the accounts of Ebbsmith in that name and in his former name of Joseph Smith, and of the Dickinson Company. Mr. Justice Hawkins reversed this order, and the plaintiff company appealed. On behalf of the plaintiffs affidavits were read which had been sworn by the plaintiffs' solicitor, Mr. Munns, by Mr. Hatchet, who was secretary to the plaintiffs, and who had been secretary to the South Staffordshire and Birmingham District Steam Tramways Company, Limited, and by Mr. Holmes, who had been cashier to the defendant and secretary of the Dickinson Company. It appeared that the signatories of the memorandum of association of the Dickinson Company were the defendant's partners and clerks, and that out of the 1,507 shares in that company the defendant had originally, and for some two or three years after, held 1,500. In 1889 the 1,500 shares were transferred by him to one of the signatories of the memorandum of association, who had previously held one share, and subsequently they were transferred to the Corporate Trust, Limited

Sir Frank Lockwood, Q.C., and Mr. Scrutton appeared for the plaintiffs, Mr. G. Spencer Bower for the defendant, and Mr Loehnis for the Dickinson Company.

The Master of the Rolls, in dismissing the appeal, said that the application was for liberty to inspect the accounts in the books of the Staffordshire Joint-Stock Bank of the defendant Ebbsmith and also of the Dickinson Tramways Appliances Company. Taking the first of those two accounts, he had no doubt that the Court had jurisdiction to make the order applied for. The question was how the Court was to exercise that jurisdiction. The extent of the power of the Court in ordering inspection of documents before trial was regulated by decisions amounting to rules, and the rule, before the passing of the Bankers' Books Evidence Act, 1879, was that the Court had power to order such inspection, subject to an answer which might be made in an affidavit by the person against whom the application was made. The Court would accept his answer, made on oath in an affidavit, and it could not be contradicted by affidavits in reply, but he would be left to the risk of being subsequently found out to have sworn falsely. The application in the present case was made under the Bankers' Books Evidence Act, 1879, but in the opinion of the Master of the Rolls the Court should exercise its jurisdiction under that Act in accordance with the rules of the Court in other applications for inspection. Therefore, as the defendant had here sworn an affidavit that the items in his banking account which he had there given were the only items in it which were relevant to the issue in the action, the Court must, for the purposes of that application, accept and act upon what he had sworn. The Court must refuse to order inspection before the trial, and would leave the judge at the trial to make any order that he might then think fit. Then as to the account of the Dickinson Company, he (the Master of the Rolls) had no more doubt in that case than he had in the case of the defendant that the Court had jurisdiction to make the order asked for. That seemed to him to be clearly the law, and the reasons for it were given by the Court in Howard *v.* Beall (23 Q.B.Div., 1). But that jurisdiction is to be exercised with the greatest caution. The Dickinson Company were not parties to the present action. At least one rule of conduct which the Court must observe in an application of this sort—though he did not say that this rule is an exhaustive one—is that if it has been proved to the satisfaction of the Court so that the Court is persuaded that the banking account which is nominally that of a person not a party to the action is really and in truth the account of a party to the action, or if it be proved in the same way that, though the account is not the account of a party to the action, yet he is so closely concerned in it that items in it would be evidence against him at the trial, and if there should be no other reason for refusing the order, then the Court may make the order asked for. But unless the Court be convinced to that extent, at least, they should not make the order. In the present case he thought that the plaintiff had established that much. But, besides that, he thought that the person making such an application as this should show to the Court that there were at least strong reasons for expecting that the account in question contained items which would be damaging evidence against the other party to the action. Here it had not been made out that there were any such items in the banking account of the Dickinson Company as would be evidence against the defendant, and he could not see why there should be any items other than those which the plaintiff already knew of. Therefore, though the Court had jurisdiction to make an order for inspection of the Dickinson Company's banking account, yet it seemed to him that, if the order were made, the Court would merely be giving the plaintiff an opportunity to try and find if there were any items which might be useful to him. The appeal must therefore be dismissed.

Lord Justice Kay concurred.—*Times.*

COMPANIES' MEETINGS AND REPORTS.

THE ALUMINIUM COMPANY, LIMITED.

The eighth ordinary general meeting of this Company was held on Monday at the Cannon-street Hotel, E.C., the Right Hon. Gerald William Balfour, M.P. (chairman of the Company), presiding.

The **Chairman** said the gross profits of the year amounted to £17,000, as against about £19,500 for last year. The difference was owing to the stagnation in the sodium trade, due to a very special cause, which was not likely to recur. That stagnation lasted throughout the winter months, but with spring the trade revived. After referring to the report, a summary of which appeared in the last issue of the *Electrical Engineer* the chairman stated that the Company had during the past year disposed of the Castner patents for the manufacture of soda by electrolysis, and stood to receive in respect of them a sum amounting in cash and shares to between £150,000 and £200,000, including £65,000 from the Mathieson Alkali Company in America—that was to say, £30,000 in cash and £35,000 in shares. In addition to that, the Company owned another important chemical invention made by Mr. Castner, the exact nature of which, at the present moment it would not be advisable to disclose. The patents for that invention in the United States of America alone had been sold for a sum of £10,000 and a third of the capital of the company which is to be formed there They had yet to dispose of those patents in England and on the Continent of Europe. Of course, from these sums there was to be deducted the 10 per cent. due to Mr. Castner under the arrangement made with him, and also any expenses in bringing out the English company, and in carrying the negotiations which have taken place to a successful issue. But after all these deductions the Board were more than justified in making the statements as to the value of the patents which were made last year. As to the criticisms and attacks that had been made on the Castner-Kellner Alkali Company, these had in no single instance come from any gentleman who had actually inspected the process as carried on at Oldbury. It would be out of place to reply to those criticisms in detail; but in reference to the high price of mercury, and the fact that the sale of mercury was more or less a monopoly in the hands of a single firm, he would point out that the new Company would not be a consumer of mercury to any considerable extent, as, after careful experiments, they had found that the waste in the course of the whole year would not amount at the outside to 2 per cent. of the mercury used and this small waste occurred in the process of handling the material, and not through volatilisation or diffusion of mercurial vapour in the atmosphere. To say, therefore that it would be dangerous to those employed was a mere mare's nest. After referring to the obligations of the Company to Mr. Castner, Mr. Balfour said that his duties elsewhere must monopolise his time and attention, and he was shortly about to withdraw from the control of the Company's affairs. It had been his good fortune to steer the Company through the most troubled waters which a public company ever encountered without foundering, and he was now able to relinquish the command after seeing the vessel safely into port. In conclusion, he moved "That the report and accounts be received and adopted, and entered on the minutes."

Sir Henry E Roscoe, F.R.S., seconded the motion, and expressed deep regret at the necessity for Mr. Balfour to withdraw from the chair which he had so ably occupied. He congratulated him on the high position he now filled, and wished him success in his great work He explained that a most satisfactory site for the Castner-Kellner alkali works had been acquired, and that arrangements had been completed for the necessary supply of salt.

Mr. Twigg asked what became of the output of caustic soda at the Oldbury factory.

The **Chairman** explained how it was they came to work at the process The Company's business had been to make sodium, and that was made from caustic soda. It was important in the manufacture of sodium that the caustic soda should be as pure as possible, and they had difficulty in getting it pure enough, and set about to try and find means of producing it themselves. The result was Mr Castner's invention. Their output of caustic soda was not distributed in the market at all, because they employed it all at their own works.

The motion was then unanimously agreed to.

The **Chairman** moved: "That a dividend of 5 per cent for the year ended June 30 last on the 'A' shares be declared, payable on the 16th inst"

Mr. Hamilton Y. Castner seconded the motion, which was carried.

The retiring directors (General Sir Andrew Clarke and Mr. Castner) were unanimously re-elected, as were also the auditors (Messrs. Broads, Paterson, and Co.).

On the motion of **Mr. Gibson**, a hearty vote of thanks was accorded the Board.

The **Chairman**, in reply, remarked that the shareholders had throughout, even in the darkest times of the Company, recognised that the directors were honestly doing their best in the Company's interest, and both the shareholders and the Board now had their reward in the increased prosperity of the Company and its hopeful prospects.

WEST INDIA AND PANAMA TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of this Company was held at Winchester House, E.C., on Wednesday last, Mr. C. W. Earle, chairman of the directors, presiding.

The **Chairman**, in moving the adoption of the report and accounts, said this was the fourth consecutive report in which the Board had had to announce a reduction in the traffic receipts for the half-year, as compared with the corresponding previous six months, although every station had been in communication, and the service had been carried on as perfectly as usual, and without complaint. The question occurred as to what was the cause of

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this constant reduction. No doubt the unfortunate state of the West Indies in regard to the low price of sugar had very much prejudiced the receipts. But, in seeking to be quite certain as to what was the real cause of the depreciation, he had taken some trouble to look into the traffic accounts, which were divided into two heads: first, the international traffic, the messages coming on to or going off from the Company's lines from or to other lines; and, secondly, the inter-colonial traffic between the different colonies served by the Company. He found that, whereas in 1885 the inter-colonial traffic amounted to £15,722, during 1894 it only amounted to £8,644, showing a reduction of nearly 50 per cent. The international traffic of 1894 was only about 9 per cent. less than that of 1885. It was quite fair to assume that while the Company's traffics were affected by the general decline of commercial prosperity in the West Indies, it would have affected both classes of business; but from these comparisons it appeared that it was the inter-colonial traffic that had been so much depreciated, and he was informed that the reason for this falling off was the great increase in "tramp" steamers which plied now through the West Indies. In former days the inter-colonial traffic had mainly to do with messages connected with the chartering of ships; now, no doubt, the merchants who had a cargo to send away waited for the call of some of the tramp steamers, who came in and plied for freights very much as we saw cabs "crawling" about the streets of London for fares. He had no doubt in his own mind that this had caused a great deal of the falling off in the Company's inter colonial traffic. It was fair to ask what the directors were going to do to remedy such a state of affairs. They had prospected all the West Indian shores for traffic to feed the system, and they had sent their general superintendent to various places to interview the merchants and others. These merchants, though delighted with the idea of having the telegraph laid to those places, were honest enough to say that they did not expect to find much use for it, nor would the local Governments promise a subsidy or guarantee. The directors therefore thought it better to leave the matter where it was. With regard to the accounts, there was very little, as usual, to say. The charges were almost all on the same scale and lines as they had been for years. The whole balance of revenue over expenditure was about £18,000, as compared with £16,000 last year, and, so far, might be considered fairly satisfactory.

Mr. William Andrews seconded the motion for the adoption of the report, and it was unanimously carried.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

The thirtieth ordinary general meeting of this Company was held on Thursday at Winchester House, E.C., Mr. W. S. Andrews, chairman of the Company, presiding.

The **Chairman**, in moving the adoption of the report, a copy of which appeared in our last issue, remarked that exchange had averaged 9⅝, as against 9¼ for the corresponding period last year. The outlook of the Company was very much ruled by that question, and if they had a satisfactory exchange they would have little to complain of. The question of the purchase of their lines by the Brazilian Government remained very much where it had been. The authority of the Government to purchase would expire if it were not used during the present year, but the Legislative Assembly had approved an application to prolong the period, and it was confidently expected that the Bill would also be shortly passed by the Senate. There was also a subject which he would have preferred to have left untouched were it not that he was anxious that no inaccurate impression on the matter should find a lodgment in the minds of the shareholders. The latter would have seen the speech of the chairman of the Brazilian Submarine Telegraph Company on the subject of a cable *vid* Ascension and the Island of Trinidad to the River Plate. Now, the Brazilian Submarine Company had no right to lay this cable, and could not lay it during the existence of the Western and Brazilian Company, because it would be contrary to subsisting agreements. But if the purchase of the latter company by the Government were carried out those agreements were *ipso facto* determined, and the Brazilian Submarine Company would be free to do as they thought fit. At present they were not The purchase had never been improbable, and must have entered into the calculations of the Submarine Company, and there had therefore been no occasion for surprise or excitement on the subject. The Government of a nation like Brazil would, there was no reasonable doubt, be guided by the interests of the country and its mercantile community, and would treat the Submarine Company with perfect impartiality. He (the speaker) must deny that the Western Company had ever acted in an unfriendly manner to the Submarine Company. The contrary had been the case, and the interests of the companies were so far identical that it would be fatuous to adopt any other policy in that respect Whether the Brazilian Government purchased their lines or not, the Company might look forward to a share in the growing prosperity of Brazil.

Lord Richard Browne seconded the adoption of the report.

Some conversation followed on the amount expended on stationery, and an alteration in the articles of association allowing the Company after a certain period to take possession of unclaimed dividends, the **Chairman** saying the Stock Exchange would not permit that. On the subject of the smallness of the reserve fund, he also remarked that a second cable had been laid from Pernambuco to the Plate out of revenue and reserve.

Mr. W. Griffiths, who was heard with some impatience, gave notice to propose at the next meeting that there should be again two auditors as formerly. He would be pleased to act as one. The resolution adopting the report and declaring a dividend of 2½ per cent. for the half-year having been carried unanimously, the meeting ended.

HARROW ELECTRIC LIGHT AND POWER COMPANY.

The first meeting of shareholders of this Company was held at Harrow last week, Mr. C. Colbeck presiding, in the upper room of the Public Hall

The **Chairman**, in the course of his speech, said the share capital of the Company was fixed at £25,000 They had now issued 2,000 ordinary shares, and £5,000 in 4 per cent. debentures had been taken up. They had allotted 1,685 shares, which, when fully paid up, would bring £8,425, and this, with the debentures. made a total capital of £13,425, which would be shortly available. That was more than enough for their wants, so far as they could foresee, but if the directors had reason to think they wanted more, they did not anticipate the least difficulty in getting it. They had purchased a site in West-street, consisting of two cottages standing in large gardens, and seven adjoining houses, the leases of which had 64 more years to run. The whole of the property was leased from the Governors and Keepers of Harrow School, and they had paid £1,350 for it, subject to a mortgage of £1,325, which brought the total cost to £2,675. The gross rental was £198 per annum. They believed it was a fair and good bargain. Had it not been for the opposition to the transfer of the provisional order, they would by this time have been far advanced towards completion and the actual starting of the light. They had now not actually signed the contract with Messrs. Crompton and Co., but hoped to do so shortly, as there were no more difficulties in the way. They had said that the cost would not exceed £11,400 to supply 3,500 8-c.p. lamps, but they found it would not exceed £10,669—in other words, they had effected a saving of £700. Their capital was provided, and they were able to go on. They had enough custom promised from the school to live, and their financial success and dividend-paying power would depend upon how much they could manage to extend their business.

In reply to a shareholder, the chairman added that it was hoped to start the light in March next, and the proceedings closed with a vote of thanks.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Brussels.—The Ministère de la Guerre invites tenders by January 15 for (1) a heating installation, (2) electric lighting in the new military school to be constructed in the Avenue de la Renaissance, Brussels.

Swansea.—The Corporation desire tenders for the erection of a destructor and electricity supply buildings, a chimney shaft, and a dust destructor, with furnaces and boilers. Particulars will be found in our advertisement columns.

Punta Arenas (Chili).—Tenders will be received until December 5 for the manufacture and laying of a submarine telegraph cable from Puerto Montt to Punta Arenas. The conditions and specifications may be consulted in the Chilian Legation, Member's-mansions, 36, Victoria-street, S.W.

Huddersfield.—Tenders are invited for the works required in erection of a mill, and include an engine-house, boiler-house, chimney, dynamo house, etc. The specifications may be obtained of Messrs. John Kirk and Sons, architects, Huddersfield and Dewsbury, from 14th to 28th inst., on which latter day sealed tenders are to be sent in to them.

Cardiff.—The Technical Instruction Committee desire tenders for the electric lighting of the new buildings in course of erection in Dumfries-place. Further particulars may be obtained on application at the college buildings, Dumfries-place, Cardiff. Sealed tenders, endorsed "Electric Lighting," must be delivered to the secretary, Mr. Jenkins, at his office not later than the 28th inst.

Paris.—The Municipal Authorities invite tenders by November 21 for the supply of two dynamos for the municipal electricity works. Conditions from L'Hôtel de Ville, Paris. Further, the Direction Générale des Postes et des Télégraphes invites tenders by November 28 for the supply of 46,280 creosoted telegraph poles in eight lots. Requests for admission to the adjudication before November 18. Specifications at rue de Grenelle, No. 103 (division du matériel et de l'exploitation électrique, 3E bureau).

Warrington.—The Cheshire Lines Committee, among other stores to be supplied in 1896, desire tenders for telegraph materials, instruments, and wire. Patterns can be seen and specifications, with forms of tender, obtained upon application to Mr. Saxon Barton, storekeeper, Cheshire Lines, Warrington, and intending contractors are requested to particularise the stores for which they wish to tender. Sealed tenders, endorsed "Tenders for ——," to be in the hands of Mr. Glegge Thomas, secretary, Central Station, Liverpool, addressed Cheshire Lines Stores Department, Warrington, by 10 a.m. on 30th inst.

Handsworth.—The Urban District Council are prepared t receive tenders for an installation of fire-alarms to firemen's house and telephonic calls to out-stations. Plans and specifications prepared by Mr. W. H. Whitehouse, electrical engineer, may be seen at the Surveyor's Offices, Council House, Handsworth, where form of tender and all information may be obtained from Thursday, the 14th, to Tuesday, the 26th inst., upon which latter day

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sealed tenders must be delivered at the above office, endorsed "Tender for Electrical Fire-alarms, etc." The tender of any firm paying less than the standard rate of wages will not be considered.

Windsor.—The Corporation invite proposals for taking over and working their electric lighting order. All proposals to include the erection and maintenance of a generating station upon a specified site, laying down mains, and necessary equipments, with a constant supply of electricity for lighting purposes in the area, as stated in above order, the Corporation reserving to themselves the right of taking over the plant at the end of a term of years, this term to be stated in the tender. The order can be inspected and full particulars obtained on application to the town clerk, Windsor, to whom sealed tenders, endorsed "Electric Lighting Tender," must be sent by January 1.

Blackburn.—Tenders are invited for the following, for the Corporation: Section B, steam alternators and motor alternator; Section C, switchboard and engine-room connections; Section D, street transformer-chambers, transformers, etc. Conditions of contract, specifications, and forms of tender, may be obtained at the offices of Mr. E. M. Lacey, 10, Delahay-street, Westminster, on payment of £3. 3s., which will be returned on receipt of bona fide tender. Applicants should state which section they desire to tender for. Tenders, sealed and endorsed "Electricity Extensions," must be delivered at the office of Mr. Robert C. Fox, town clerk, Town Hall, Blackburn, by 30th inst.

York.—The directors of the North-Eastern Railway are prepared to receive tenders for the undermentioned articles, in such quantities as they may require during the six months ending June 30, 1896, delivered carriage paid at the company's telegraph stores at York—viz., (1) telegraph apparatus, (2) telegraph wire and line stores. Payment for each month's delivery will be made at the end of three clear months, or in cash less 2½ per cent. discount Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York, and tenders must be sent in to the secretary at York, sealed and marked "Tender for Telegraph Stores," not later than noon on November 26.

Derby.—The Midland Railway Company, among other stores, invite tenders for the supply of (10) telegraph instruments; (10A) galvanised telegraph stay-rods, bolts, etc; and (10B) telegraph and signal wires. The patterns will be ready for inspection at the General Stores Department, Derby, and forms of tender may be had on application being made to Mr. G. Morrall, Derby, care being taken to give reference to the particular contract (by the above numbers) for which it is proposed to tender. Tenders, addressed to the secretary of the General Stores Committee, Midland Railway, Derby, and endorsed "Tender for Stores," must be sent so as to be received by 9 a.m. on 19th inst. Mr. James Williams, secretary, Derby.

Durban (Natal)—The Corporation of Durban desire tenders for No. 40 cast-iron service-boxes for connections from concentric mains, No. 120 cast-iron service-boxes (or handholes) for house connections, No. 60 cast-iron junction-boxes for arc lamps, No. 70 cast-iron manhole frames and covers, and No. 60 ornamental cast-iron arc pillars, 25ft. high. The manufacturer must submit with the tender the designs of what he proposes to supply. Duplicate conditions, specification, and bill of quantities may be obtained from the consulting engineer, Mr. W. H Radford, C.E, Pelham-chambers, Nottingham, on deposit of £2. 2s, which will be returned on receipt of bona fide tender. Sealed and endorsed tenders must be delivered at the office of Messrs. Webster, Steel, and Co., 5, East India-avenue, Leadenhall-street, London, E.C., agents to the Durban Corporation, by 27th inst.

London, S.E.—The Metropolitan Asylums Board desire tenders for the execution of wiring and other work in connection with the electric light installation at the Brook Hospital and Ambulance Station, Shooter's Hill, S E. Copies of the specification, form of tender, conditions of contract, and of the drawings which have been prepared by Prof. Kennedy, LL D, F R.S., 14, Old Queen-street, Westminster, can be obtained of Mr. T. Duncombe Mann, clerk, Norfolk House, Norfolk-street, Strand, W.C., on and after 4th inst., upon depositing gold or Bank of England notes to the value of £25, which will be returned only to those who send in a bona fide tender, and who return the drawings, specification, and conditions of contract Tenders which will only be received on the lithographed form supplied by the Board, must be sealed and endorsed "Tender for Wiring, etc.," Electric Light, Brook Hospital," and must be delivered at the offices of the Board by 11 a.m. on 18th inst. Unless the tender be accompanied by the specification, conditions of contract, and the drawings, it will not be considered.

RESULTS OF TENDERS.

Tunbridge Wells.—The Lighting Committee have accepted the tender of Mr. Every for brackets to be attached to the arc lamp-posts at 17s. 9d. each.

St. Marnoch's (co. Dublin).—The contract for the electric lighting and pumping plant at St. Marnoch's, co. Dublin, to the specification of Mr. Morgan Williams, C.E., has been placed with Messrs. Edmundson, Limited, of Dublin. The motive power is to be derived from oil-engines.

Cheltenham.—The Corporation have accepted the tenders of Messrs. Siemens Bros. and Co. for a new switchboard at an inclusive price of £165 fixed and connected up complete, and for a regulating resistance for the new machine at £12. 10s. The electrical engineer reported that he was not yet prepared to report on the tenders for arc lamps and transformers as the tests were not complete, and it had been necessary to obtain modified tenders or the transformers.

BUSINESS NOTES.

Aston Manor (Birmingham).—A new electric light plant for the baths and public offices is proposed.

Bowness (Cumberland).—The Urban District Council have made a two years' contract for electric lighting.

Tilsit.—The Allgemeine Elektrizitätsgesellschaft purpose constructing an electric tramway at Tilsit at their own cost.

Leeds—Mr. R. Gaudin, of the British Traders' Mercantile Agency, has been appointed Russian Vice-Consul for Leeds.

Rotherham—The Town Council have appointed a committee to make enquiries on the subject of electric lighting and tramways.

Dewsbury.—Five additional installations in shops are reported, including eight arc lamps. Mr. R. Turner is responsible for the work.

Plymouth.—The Town Council have decided to appoint a special electric lighting committee in place of the present small sub-committee.

Derby.—The Town Council have resolved to apply to the Local Government Board for sanction to borrow £4,146 for electric lighting purposes.

Zurich.—The new academy of music is to be connected to the alternating-current system of the town of Zurich, Pollak rectifiers being brought into use.

Sandwich.—Negotiations are being carried on by the town surveyor with the landowners for the construction of a tramway to the seaside, a distance of two miles.

Brighton.—A special meeting of the Brighton Town Council has been convened for Saturday next to further consider the Rottingdean electric railway question.

Sale (Cheshire).—The clerk to the District Council has reported that he had received no reply to his communication to the Ashton Urban Council regarding the electric lighting.

Telegraphs in Mashonaland.—The telegraph line between Umtali and Beira has been opened, thus completing communication overland from Cape Town to the East Coast.

Metropolitan Asylums Board.—The Brush Electrical Engineering Company have been added to the list of selected firms invited to tender for work for the Brook Hospital Committee.

Walsall.—The General Purposes Committee have recommended the purchase of two additional transformer armatures for the electricity supply works from Parkers, Limited, at a total cost of £224.

Weybridge.—The Urban District Council have appointed a committee to confer with Mr. Martindale as to the transfer of the provisional order from the Weybridge Electric Supply Company to the Council.

Electric Tramways in Persia.—Herr Felix Moral, a German subject, has obtained a 90 years' concession for a steam or electric tramway, about 10 miles in length, from Teheran to the villages north of the city.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended November 10 amounted to £1,063, as compared with £892 in the corresponding week of last year, being an increase of £171.

Vienna.—The Akkumulatoren-Fabrik Aktiengesellschaft purpose introducing as an experiment lead-accumulator cars on the line between the Franz Joseph railway station, the Quai, the Ringstrasse, and the Porzellangasse.

Dover.—The Corporation have passed a resolution applying to the Board of Trade for the necessary powers to enable them to construct electric tramways throughout the borough, the majority of the main streets being scheduled.

Victoria Electric Railway and Lighting Company, Limited.—The numbers have been published of the 5 per cent. first mortgage debenture bonds, amounting to £1,000, drawn for repayment on January 2, at the rate of £105 per cent.

Johannesburg (South Africa).—The Sanitary Board have decided to use the Brockie-Pell arc lamp for the lighting of the streets, and an order has been placed with Messrs. Johnson and Phillips, London, for upwards of 50 lamps.

Monmouth—The result of the municipal election is taken as showing that the ratepayers are favourable to the proposed electric lighting scheme, the retiring councillors who supported the scheme having been re elected by substantial majorities.

Newport (Monmouth).—The Town Council have decided, subject to the sanction of the Local Government Board, that they will purchase for the sum of £1,000 the spare electrical plant which had been hired from Messrs. Fowler and Co., Leeds.

Newcastle-on-Tyne.—The Town Council have passed the formal resolution for promoting in the ensuing session of Parliament a Bill which, among other matters, gives powers to construct tramways and work them by electricity, petroleum, or other motive power.

Wolverhampton.—In their annual report the Lighting Committee refer at some length to the introduction of the electric light, and state that they have every reason to believe that during the ensuing season the business of the undertaking will be largely developed.

Dundee.—At a meeting of the Guildry to appoint representatives on the Harbour Trust, there was some discussion on the desirability of an electric tramway to the eastern jetties. It was understood that the trustees would take the matter into consideration.

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Christiania.—The proprietors of the Roros Copper Works are reported to have placed a contract with a firm in Christiania for a large electrical plant, it being intended not only to light their mines by electricity but also to operate all the mining machinery electrically.

Agency. — Messrs. Musgrave Bros., hydraulic and general engineers, of Leeds, have appointed Messrs. Julius Harvey and Co., engineers and merchants, of 11, Queen Victoria street, E.C., as their representatives for London and district for the home and foreign trade

Lambeth (London).—A meeting has resolved that the members of the Vestry present should be asked to support an application to the Board of Trade for an extension of time in which to consider the question whether the Vestry should or should not adopt electric lighting in the parish.

Ripon.—The Dean and Chapter have instructed Messrs G. Harrison and Co., of Ure Bank Works, to proceed with the experimental electric lighting of the cathedral, and they hope to have the generating machinery and two Brockie-Pell arc lamps at work early next month.

Yarmouth —The report to the Town Council on electric lighting shows that during the past month £104 5s. 5d. was earned beyond the cost of production, from which had to be deducted repayment of capital, interest, depreciation, rates, and taxes, which amounted to between £85 and £90 per month.

Taunton.—The municipal electrical engineer has stated that the demand for the electric light was steadily increasing, and they had added 140 16 c.p. lamps during the quarter. The maximum load on the private lighting circuits was about 20 per cent. greater now than it was at the corresponding quarter of last year.

City and South London Railway.—The returns for the week ended November 10 were £1,009, compared with £969 for the corresponding period of 1894, being an increase of £40. The total receipts for the half-year 1895 are £16,658, compared with £16,719 for the corresponding period of 1894, being a decrease of £61.

Belfast.—At the meeting of the Electric Committee, we understand that a complaint was made by the engineer (Mr. M'Cowen) with regard to the working of the present gas-engines, and as these engines had been already tested by Prof. Kennedy the committee decided that his attention should at once be drawn to the matter.

Alderley (Cheshire).—The Urban District Council have received a letter from Mr. Clirehugh with reference to the transference of the electric lighting provisional order to a private company, suggesting a few alterations on technical points in the agreement of purchase which had been drafted. These were practically agreed to.

Dublin.—Dr. Wm Carte, Messrs. William M. Murphy, John R. Wigham, and William Anderson, directors of the Dublin tramways, have returned from the United States, where they have been to study the various methods of street transit, especially electrical ones in use, with a view to the selection of an appropriate system for Dublin.

Telephones in Hampshire —The County Council have received a committee's report to the effect that the National Telephone Company had agreed to considerably reduce the rents of the existing telephones, and that new connections would be made at Aldershot, Basingstoke, Cosham, Fareham, Farnborough, and Lyndhurst.

Ashton-on-Mersey.—The Urban District Council have adopted a resolution to put into force the Electric Lighting Provisional Order of 1883 and 1888, as to an agreement come to between the Council and the Altrincham and District Electric Supply Company, Limited, for the supply of electric light in the district covered by the Council.

Chelsea.—Specifications are being prepared for the wiring of the new workhouse buildings in Sydney-street for electric light. The Chelsea Electricity Company have written to the Guardians stating that their sliding scale for current would be 5d. per unit, 1d. less than the usual charge, and a further reduction when warranted by an increased consumption.

Timperley (Cheshire).—Mr. Bell has reported to the Rural District Council having examined the proposed application to supply electricity to Timperley, and he saw no objection, provided the road were made good again subject to the approval of their surveyor. No opposition was offered by the Council to the proposed application for a provisional order.

Aberfeldy.—An interesting experiment has taken place on Loch Tay. Trial trips have been made with the "Mystery," an ordinary keel boat 16ft. in length, built at Clydebank, and purchased by Mr. John Macdonald, of Beechwood Cottage, Strathtay, who has fitted it with his patent electric battery and electrical gear. The boat ran the nautical mile in nine minutes.

Fulham.—At a meeting of the Electric Lighting Committee of the Fulham Vestry five engineers were interviewed—viz, Messrs. R. Hammond, T. W. Baker, E. Manville, F. H. Medhurst, and G. Wilkinson. Mr. Medhurst obtained the appointment of consulting engineer to the Vestry, the final voting being: Mr. Medhurst, six votes; Mr. Manville, three votes.

Coventry.—Posts and wires are now being erected for running the tramway from Coventry to Bedworth on the overhead system. A trial trip over the new tramways from the depôt at Foleshill to the Coventry station has been made by one of the new electric cars. The system is the Thomson-Houston overhead wire system. The car was illuminated by electricity, and the run was successful.

Southampton.—In reference to a paragraph in our last issue, it should have been stated that the Dock Estate has been lighted since 1893, and the new electric lights referred to are necessary in consequence of extensions at the new dock. Moreover, the quays belonging to the Harbour Board are lighted electrically, so that the Mersey Dock Board can hardly claim priority in this matter.

Proposed Electric Railway in Derbyshire.—Plans of the proposed new light railway from Derby to Ashbourne have just been completed. Levels of the roadway have been taken, and the usual parliamentary notices will be published this week. The Bill for the construction of the new line, which is to be worked by electricity, will be deposited in Parliament at the earliest possible moment.

Devonport —About two years ago the dockyard officials suggested that the internal portions of ships in course of construction should be lighted with electricity. Their Lordships gave authority for using the spare dynamos and lamps in the dockyard for this purpose, and the results have been so satisfactory that the Admiralty have decided to replace the temporary gear by permanent plant of the most modern type.

Bangor (North Wales).—In spite of the resolution of a ratepayers' meeting and several numerously signed petitions, the Town Council are going on with their electric lighting scheme. A local paper says the dispute has now reached a stage at which it is not so much a question of whether the electric lighting scheme is good or bad, but whether the Council is to set at defiance the predominating wish and determination of the burgesses.

Glasgow.—The directors of the Glasgow Chamber of Commerce have received a letter from the Postmaster-General regretting delay, due to the recent unforeseen increase of telegraphic business, in the transmission of messages between Glasgow and London. The Postmaster-General, the letter added, was making provisional arrangements to improve the service. The Chamber, however, regarded the communication as unsatisfactory, there still being great delays.

Streatham.—One of the surveyors of the National Telephone Company has attended a meeting of the District Board and asked permission to lay a telephone cable under the footpath at Streatham-hill. At present, he explained, communication between the City and Streatham has to be carried on by way of Croydon. The Board had offered to allow a cable within a disused sewer, but there were objections to this. The Board granted the request of the company.

Islington.—The Vestry have decided that their new underground conveniences to be constructed near Archway Tavern shall be lighted by electricity. The completion of the loan to the Vestry for the purchase of land for the electric lighting station has been reported by the Finance Committee of the London County Council. The Vestry have purchased a piece of land from the Great Northern Railway Company for an electric lighting siding at Holloway, at a cost of £257.

Mevagissey (Cornwall).—Mr. James Kemble has reported to the Parish Council on the progress made with regard to the formation of an electric light company. About £300 more remained to be raised to complete the necessary capital, and if the Council would give the promoters a fortnight to issue a prospectus, they would probably be able to give the Council definite information, and proceed at once with the lighting of the town This was agreed to.

The International Electric Company.—We have received from this Company, whose address is 55, Red Cross-square, Barbican, E.C, a copy of their new catalogue. It is a well got up volume of 200 pages, and deals with electric bells, indicators, switchboards, telegraph instruments, electro-medical apparatus, microphones, and telephones, the firm calling special attention to the last section. It is copiously illustrated, and provided with an index to facilitate reference.

The New Regulations for Electric Lighting.—The draft of the revised regulations for securing the safety of the public and for ensuring a proper supply of electrical energy, which have been prepared by the Board of Trade, will be considered at a meeting of representatives of municipal corporations, electric lighting companies, and others interested in electric lighting to be held at the Westminster Town Hall on Tuesday next, the 19th inst., Sir Courtenay Boyle, K.C.B., presiding.

Copper.—The copper circular of Messrs. D. Houston and Co., of New York, states that the actual consumption of the metal in America continues on a large scale; but manufacturers seem to be pretty fully stocked, and activity in copper is not anticipated until the close of the year. Messrs. Houston expect that the development of electric traction in Europe will soon be an important factor in the future of copper consumption. They also refer to the proposal to construct 84 miles of electric tramways in Japan.

Neston (Cheshire).—The District Council have received a report from Mr. O. March, London, on an electric lighting scheme. The report stated that the conditions were favourable, gas—not in the hands of the Council—being dear and steam coal cheap, but against this was the fact of the district being scattered. Under the scheme the alternating current would be adopted and the district divided into three circuits—Neston, Little Neston, and Parkgate. The plant would cost £6,000. It was decided to call a meeting of ratepayers to consider the scheme.

New British Electric Installation Company.—It is stated that the official receiver (Mr. Luke J. Sharp) has laid the whole of the facts arising out of the bankruptcy of the New British

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Electric Installation Company (Worcester) before the Board of Trade, and that body has ordered a public examination before the judge of the county court (Sir Richard Harington), unless power is obtained from the Lord Chancellor to delegate the duty of presiding at the examination to the registrar. It is understood that the judge will make the necessary application to the Lord Chancellor.

J. C. Howell, Limited.—Mr. Sidney F. Isitt (liquidator), of 6, Old Jewry, E.C., writes: "The paragraph appearing in your edition of the 8th inst. has been brought to my notice. I beg to state that the liquidation has been brought about, by the wish of the shareholders generally, for the purpose of disposing of the business and assets of the Company. Under the liquidation the shareholders have consented to my disposing of the same to Mr. J. C. Howell as from the 1st inst., and negotiations are in progress for this purpose. The liabilities of the old company will be discharged not by me, but by the purchaser."

City of London.—Dr. Sedgwick Saunders, the medical officer of health, in his report to the City Commission of Sewers says that the extension of installations of electricity has marked a new era of sanitation, and much benefit must accrue to the moral and physical condition of the employés in large commercial establishments who had hitherto been condemned to work long hours by day and night in gas-heated, ill-ventilated basements. At the end of the year, there were nearly 3,000 private consumers of electricity, using upwards of 136,000 incandescent lamps, and 483 electric lamps were now placed in the principal streets, displacing 1,338 gas lamps.

Cheltenham.—The Town Council, acting on the report of their electrical engineer that it was very advisable, in order to economise labour and time and to minimise liability to breakdown, that all the sub-stations should be connected by telephone to the Manchester-street sub-station, at an estimated cost of £100 to £110, have resolved that an order, provisional upon the consent of the Local Government Board being obtained to the further loan of £10,000, be given for the length of cable required for the extension from Cambray to the Belle Vue; and that telephone wires be laid down with all new cables between the Manchester-street sub-station and the other sub-stations.

Crompton Company of Australia.—In the Chancery Division Mr. Justice Stirling was asked, in the debenture-holders' action of Whiffen *v* the Crompton Company, Limited, of Australia, to continue the appointment of the receiver and manager. It was stated that there was every prospect of the Company's business - which was now being carried on at a profit—being sold either to another company to be formed for the purpose of acquiring it, or to one of the established companies in England which might be desirous of extending its operations in Australia. The agent of the receiver was now on his way to this country with a view to assisting in the negotiations. His Lordship extended the appointment for a day fortnight.

Bristol.—Messrs. King, Mendham, and Co. have found their present premises of the Western Electrical Works in Narrow Wine-street inadequate to the carrying on of their business and have taken new premises at 10, Victoria-street. Extensive alterations are being made to adapt these premises to the requirements of a manufacturing business, and they will shortly be opened with a large stock of fittings and apparatus for experimental use, as well as for the practical application of electricity. The Stapleton Urban District Council have appointed a committee to visit Bath and Taunton, as well as Bristol works, with a view to deciding on the adoption of the electric light. They have also asked if the Barton Regis Guardians will take the electric light at the workhouse.

Edinburgh.—The Leith Corporation have proposed to confer with the Edinburgh Town Council as to the best mechanical means of working the tramway system. On the motion of Mr. Mackenzie, convener of the Electric Lighting Committee the Town Council have made a remit to the Lord Provost's Committee with powers to consider the advisableness of adding another engine and dynamo to the electric light station, as unless something were done immediately they might soon have to refuse customers. Mr. Cranston suggested that if the price of electric power during the day was made the same for lighting as for motors—viz., 3½d. per unit—there would be a great increase of consumers who would use it for show purposes. The Lord Provost said this was the first winter of the light, and the committee should have time to look about a bit.

Paisley.—The Town Council have received a letter from Dr. Bottomley, in which he stated that he would be glad to act as consulting electrical engineer in the matter of the electric lighting of the Town Hall and the museum, and that his fee for drawing specifications etc., and superintending the work and testing it when complete, would be £105, with travelling expenses, if the work in the two places should go on simultaneously. The clerk was instructed to write Dr. Bottomley accepting these terms. A letter has also been received from the engineer and manager of the Caledonian Electric Supply Company, Limited giving notice that his company intend to apply for a provisional order for the electric lighting of the burgh and asking that before coming to a decision on the matter the Council would give his company an opportunity of submitting a copy of the terms they would be prepared to offer.

London County Council.—The chief officer of the Fire Brigade has asked that the system of telephonic apparatus at the chief station may be made uniform with that at the superintendents' stations. The Post Office has intimated that the charge for making the necessary alterations and providing and maintaining the necessary new switching apparatus is estimated at £67. 10s. per annum, subject to the same stipulations as were agreed to when similar apparatus was fitted at the superintendents' stations. Annual charges amounting to £9 in respect of apparatus which will be dispensed with will cease, and consequently the estimated net additional annual charge will be £58. 10s. The committee have recommended that, subject to an estimate being submitted to the Council by the Finance Committee, as required by the statute, the necessary expenditure in connection with the rearrangement of the telephonic apparatus at the chief station be sanctioned.

Tunbridge Wells.—The Mayor has reported to the Lighting Committee the result of his personal inspection of the machinery at the central station, and the engineer has submitted his tests, and the committee resolved that the machinery be not accepted, but they would be ready to consider any communication from the contractors. Mr. Preece's attention was called to the condition of the gas-engine, and he was requested to report upon the machinery as soon as possible. The Works Committee wrote enquiring at what rate the current could be supplied for motive power, and 3d. per unit was fixed. Mr. Nash was appointed assistant engineer at a commencing salary of £90. Extensions of the electric mains in Vale-avenue, Crescent-road, Lansdowne-road, and Pembury-road were decided upon. A resolution from the Tradesmen's Association as to the hours of supply of current was received, and it was decided to supply the current for longer hours pending a continuous supply.

Ayr.—Bailie Ure has given notice that he will move at the Town Council, "That a small committee be appointed to consider the advisability of adopting tramways between Ayr and outlying districts to be driven by electric or other motor, to enquire and report." A minute of the Lighting Sub-Committee of the Police Commissioners stated that it was decided to place an electric lamp in the centre of the Old Bridge, another at the corner of George-street and Wallace street, and a third at the corner of George-street and Content-street. Mr. Grant asked the convener of the Lighting Committee if the meters were not ready now. Some of those who were having the electric light introduced to their premises would like to have the work finished, whether the light was turned on or not. Bailie Ure said their present intention was that they would be able to give the light to the library and the Town Hall about the beginning of December, but he would not advise the streets being lighted till the end of the month.

Harwich.—The Public Health Committee have received from the Town and Village Electric Light and Power Company, Limited, the following alternative proposals: (1) to provide for the Corporation a complete installation of electricity for power as well as for light, and to take payment therefor by instalments extending over 40 years, the sum from time to time remaining unpaid bearing interest at 3 per cent; or (2) to take over the power of the Corporation under the Harwich electric lighting order upon the following terms—viz.: (*a*) to provide the installation without any cost to the borough, and to enter into a contract for the supply of electricity for public lighting for the term of 14 years, at the cost of 4½d. per unit (*i.e.*, the equivalent to 2s. 3d. per 1,000ft of gas); (*b*) to pay the Corporation £300 by an allowance of a 10 per cent. discount off each quarter's account for public lighting until the whole of the £300 is absorbed. The committee, after consideration, recommended the Town Council to accept the second proposal, and after a long debate a resolution to that effect was carried by the casting vote of the Mayor.

Runcorn.—The Electric Lighting Committee have recommended that the Urban District Council should apply for a provisional order for electric lighting. Dr. Gastaldi, in moving the adoption of the report, said that with a capital of £11,000 the Council would be enabled to provide 2 000 lights of 16 c.p. The cost of interest on a sinking fund of £11,000 would be £750. The cost of providing the electric light sufficient for the lighting of the public streets and also for private individuals would be £800 per annum, making a total of £1,550. This would be the total expenditure incurred. If they used 500 lights for the streets they would still have 1 500 to sell, and supposing they sold them at the rate of 10s. a lamp per year they would realise the sum of £750. Adding to that the sum of £1 000, which was at present paid by the Council for lighting the streets and public buildings, they would have a revenue of £1 750. Deducting from that the expenses of £1,550, they would have a balance of £200. After considerable discussion, an amendment was carried by one vote referring the matter to a committee of the whole Council for further consideration.

Swansea.—The Corporation's tramway scheme provides that the tramway company is to have a lease for 21 years, and at the expiration of that time its rights will cease and the rights of the company will pass to the Corporation, who will be at liberty to lease the system to whoever they choose. The conditions are—assuming that the cars are in future to be worked by electricity supplied by the Corporation from the electric lighting and destructor works about to be erected—that the Corporation advance to the tramway company £10,000 to enable it to pay off its debenture-holders, and £22 000 to enable it to purchase say. 20 motor cars, etc., at about £1,000 each. In addition to that the Corporation advance £20,000, to be expended on the putting of the line into a proper state, erecting posts, etc. For this £52,000 the company pay interest at the rate of ½ per cent. more than the Corporation would have to pay for it, and with respect to the £20,000 the company would, by means of a sinking fund, repay it in 21 years, and with respect to the £32,000 the company would by the same means repay it in 30 years. The company expect much economy in the substitution of electric traction. It is estimated that if the Corporation supply the tramway company with electricity at 2d. a unit, 4d. per car mile would cover the cost of traction and repairs

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against 8d. at present paid. The lines are to be kept in repair by the Corporation, which will have power to charge the company with the actual cost. The scheme has been approved by the Town Council, who have decided to promote a Bill in Parliament next session to carry it out.

Cardiff.—Mr. B. Eustace Good, of Cardiff, writes to a local paper as follows: "As a tentative suggestion, I would propose that the Corporation, upon the purchase of the tramways, should convert the Canton to St. Mary-street route into an electric line, the power being obtained from the Corporation electric light station, which is in comparatively close proximity; the steam and electrical plants being necessarily supplemented for the purpose. As a result of enquiries, I find that the approximate cost of the conversion of the Canton-St Mary-street line would not exceed £20,000. The money expended upon the construction and equipment of the Leeds Roundhay Tramway (5¼ miles) was £23 000 According to "Duncan's Tramway Manual," the average cost of horse tramways is 9·50d. per car mile; that of electrical lines 5 00d. Little fear, therefore, need be entertained but the line would pay from the first. Glasgow has unmistakably proved that tramways should, and can, be profitably worked by a municipality, with cheaper fares, faster travelling, and better accommodation. I have clearly shown that Cardiff, by adopting electric traction, can even improve upon Glasgow's magnificent triumph of municipalisation."

British Electric Traction (Pioneer) Company, Limited.—This Company has been formed, with a capital of £100,000 in £10 shares, to take steps for the development of electric traction in the United Kingdom and elsewhere on systems which have already proved successful in the United States and on the Continent of Europe. The Company will also investigate and test new and improved methods, and in due course will form a larger company with adequate capital. The prospectus states that the Company is not committed to the use of any particular system, but will aim at developing electric traction in the most approved ways and according to the requirements of each locality. Some important inventions and proposals relating to electric traction have been, it is added, submitted to the directors, and will receive early attention. The Electric and General Investment Company, Limited, have agreed to pay all expenses of the Pioneer Company up to allotment and to give its assistance in the launching of the proposed larger concern. The profits of the Pioneer Company will depend, it is said, upon the successful issue of the capital of this larger company. The subscription list opens and closes to-day (Friday).

Birmingham.—Mr. Alfred Dickinson, of the Birmingham Central Tramways, writes to the Birmingham *Daily Post* respecting the proposed electric trams for Nechells: "Will you permit me to point out to Mr Frederick J. Colbeck, and those people who think with him, that it is not proposed, in the equipment of the Nechells route to disfigure the street with a network of wires, similar to Coventry and elsewhere, as suggested by him. It is proposed simply to substitute for the existing lamp posts (on one side of the road only) combination poles—that is, a pole which will act as a support for the ordinary street lamp and for the trolley wires. There will be no cross-wires from one side of the street to the other. but simply a small wire, a ¼in. in diameter, running parallel with the track, and not coming out from the footpath over the road more than an average of 12in. practically running over the gutter. Many people seem to think that it is proposed to introduce something in the way of an experiment I should like to point out that in America and on the Continent of Europe there are over 600 distinct electric tramways, operating at least 15,000 motor cars, on 5 000 miles of street lines; that last year over 70 million car miles were run, and over 770 million passengers carried."

Stratford-on-Avon.—With reference to the proposed Stratford-on-Avon railway, Mr. T. C. Sharp, of Birmingham, writes to a local paper: "Your correspondent, 'A Supporter of the Scheme,' in suggesting that the Warwickshire County Council should construct a light railway on the site of the above, in the event of the undertaking being abandoned, offers a most important consideration for the farmers in the vicinity of the proposed railway. I do not know what the estimate for the carrying out of the present scheme is, but the sum would not be less than £250,000, and for this outlay the agriculturist could be accommodated with 125 miles of tramways by the sides of the highway in a similar manner to those adopted in Belgium, in place of about 22 miles, the length of the proposed line. It cannot be too clearly understood that the chief object of the new main lines now contemplated is to facilitate competition for through traffic, more than for the benefit of the farmer. Lord Winchilsea's scheme will do much to lower the present prohibitive railway rates for agricultural produce, and his proposal to form a co operative association for farmers will. in addition to being the best organisation for their benefit, also ultimately convince the British agriculturist of the urgent need of some cheaper means of conveyance for their stock and produce than the present railways can possibly afford."

Torquay.—The Electric Lighting Committee of the Town Council have recommended that the necessary steps be taken for carrying out the first report of Mr. W. Trentham, M.I.M.E, with respect to providing a central station with plant and machinery under the Bath Saloons, and distributing mains for lighting the compulsory area referred to in the Torquay Electric Lighting Order, 1891, and that application be made to the Local Government Board for sanction to borrow £18,000 required for the purpose. Mr. Kerswill, moving the adoption of the recommendation, said the time had come when Torquay must take action in the matter and introduce the new light. No doubt they had gained something by waiting, but they ought not to wait longer. Over 80 towns in England had introduced the light, and 42 local authorities had kept the power in their own hands. Towns adopting the light had shown a profit in the first year, and considerable profit after working for two or three years. Mr. Trentham had since written that the details of his scheme A might be modified a little with advantage. In going carefully into the tabulated results of electric light working in various towns, he found that he had overestimated the working expenses and slightly underestimated the revenue. At 6d. per unit the revenue would amount to £3,300, or, with arc lamps, to £3,600; whilst the working expenses would be £1,160, and, adding interest at 6 per cent., £2,292, leaving a net profit of £928, not allowing any revenue from meters, motors, or cooking apparatus. The fact that private companies were applying for powers for lighting Torquay with electricity was sufficient to warrant the Town Council in introducing the light. Ultimately the subject was referred to a committee of the whole Council.

Bury St. Edmunds.—The report of the committee appointed to consider the question of the advisability of lighting the town by electricity has been laid before the Town Council. The report showed that three meetings were held, and at the first of these Mr. Turner was appointed chairman. After some discussion it was agreed that before bringing the question of electric lighting before the Council an expert be asked to give a report as to the advisability and prospect of a favourable financial result. At the second meeting, held on October 25, letters were read from several electricians offering to visit the town and report on the subject of electric lighting, amongst them being Mr. Medhurst, who offered to attend a meeting of the committee at his own expense, and to give a full report for an inclusive fee of 25 guineas. This was agreed to, and Mr. Medhurst attended an adjourned meeting, and explained a proposed method of public lighting and the probable capital expenditure and income, and it was resolved the Council be recommended to engage Mr. Medhurst to prepare a report and specification upon the electric lighting of the town at a cost of 25 guineas Mr. Turner, in moving the adoption of the report, said, as they had before them a very able report of the scheme of electric lighting at Tunbridge Wells, the committee had thought it advisable to write to Mr. Preece, and he (Mr. Turner) had visited Tunbridge Wells The work there had been very excellently done, but in his opinion a great deal more money had been spent than need have been. Mr. Preece had offered to come down and advise them and to prepare a report and scheme for the sum of 50 guineas. A discussion followed, Mr. A. J. Hooper at once raising the question whether councillors who were shareholders in the gas company could speak and vote The town clerk gave it as his opinion that they could do so. Ultimately it was unanimously agreed that 50 guineas be substituted for 25 guineas in the report, and the last clause was altered by the deletion of the name of Mr. Medhurst and the substitution of the word "expert" and the report was then adopted. It was also decided that telephonic communication should be established between the officers of the fire brigade and the police station, with electric bells and wires from the police station to the residences of some of the men, and that the National Telephone Company should do the work.

Blackpool.—The Electric Lighting Committee of the Corporation is now to consist of all the members of the Council. It has been decided to greatly improve the tramway service in the borough. Powers have already been obtained to construct a line by Cow Gap-lane and Whitegate-lane, and it has been now agreed to ask for further powers to lay down a line along the northern section of the Promenade to the end of Claremont Park returning by way of Dickson-road and Warbreck-road to the Talbot-road Station. Another new line is to be made *vid* Talbot-road and New-road to the cemetery, and it is proposed in each instance to employ electric traction. The Electric Lighting and Tramways Committee have applied to the Board of Trade for consent to the Corporation working the Lytham-road tramways, south of Station-road, by electrical power on the accumulator system, and have received it. Two letters were also read from the Board of Trade in reference to the recent accident in the electric lighting street boxes, and a memorandum by Major Cardew, R E. the electrical adviser of the Board. The town clerk was instructed to reply that the Corporation propose adopting the recommendations of Major Cardew. A letter was read from Mr. B Sykes, on behalf of a proposed company for constructing a tramway from Blackpool to Fleetwood, applying for the consent of the Corporation to the company constructing tramways in the borough, north of Talbot-road railway station and through Claremont Park to the northern boundary of the borough, or for a statement on what terms the Corporation would lease to the company any lines constructed by the Corporation in the direction indicated. It was resolved that as the Corporation are about to apply for further powers for their tramways, and for the construction of new tramways in the northern portion of the borough, the Corporation are unable to accede to the requests contained in the letter. Resolved, the Corporation apply to Parliament in the ensuing session, either by Bill or by provisional order, for the laying of a double line of tramways in Station-road; also for the laying of tramways along Dickson-road, Warbreck road, to the Gynn, to the northern boundary of the borough; and along Cocker street to Dickson-road; and from Cocker-street northwards in front of Carlton-terrace and along Queen's drive to the Gynn and that the town clerk be instructed to take all proceedings requisite in the matter. The committee desired to place on record their appreciation of the services to the electric lighting department rendered by Mr. Robert Hammond, consulting electrical engineer,

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during his association with the Corporation, and their satisfaction with the system of electric lighting adopted by them on his advice.

Ipswich.—The County of London and Brush Provincial Electric Lighting Company, Limited, have written to the Council stating their intention to proceed with their notice of application for a provisional order for electric lighting in Ipswich, and Mr. E A Paris, the representative of the company, has attended a meeting of the Paving and Lighting Committee, and stated that when he attended before the committee felt that the matter was beyond the province of the committee, and that the Electric Lighting Committee was either defunct or had completed the work for which it was appointed. The company afterwards made application to the Council, but from some misadventure it did not reach the town clerk till too late to be placed upon the agenda paper of the Council meeting then to be held. Since then the company had been unable to get any further, and they had waited to hear the views of the Corporation. They would ask whether the Corporation meant to oppose pure and simple, or whether some common basis of negotiation could be found by which they could come to an agreement to purchase the undertaking, either after a term of years or immediately after the installation was put down. What the company desired was some means of getting the matter further discussed. If the committee could see their way to further the company's views and bring the matter before the Council or a special committee to discuss these points, the company would be very pleased to take any step the committee might suggest. It was necessary for the company to publish advertisements during November of the streets in which they intended to lay their wires, and before they went further they would like some expresssion of opinion from the Council. The Town Clerk said it was unfortunate that the company were always a few days too late. Last summer the company were advised when the Council meeting would be held, and then made their proposition only a day or two before that date, altogether too late to get the notice on the agenda, and they were in just the same position now, though it was perfectly well known that all over England the annual meeting of every town council was held on November 9 The matter could not now be discussed this month. Mr. Pratt said, notwithstanding the incandescent lamps, many would like the electric light, and suggested the possibility of holding a special meeting of the Council. Mr Paris enquired when the next Council meeting would be. The Town Clerk said the second Wednesday in December. The company would have to issue their advertisement before then Mr. Paris agreed, and promised to supply to the Council full details as to the area of compulsory supply. It will be remembered that the electric light was at one time supplied in Ipswich by a company. The enterprise, however, from various causes did not succeed, and there are at present in the town establishments wired and fitted for lighting and unable to obtain any current.

Manchester.—At the last ordinary meeting of the Board of Directors of the Chamber of Commerce the question of telegraph charges to the Far East was discussed. In view of the international telegraph conference to be held next year at Budapest, the India, China, and Colonial Committee had had under consideration the high charges at present levied by the telegraph companies for messages between Great Britain and India and the Far East. Following up previous representations from this Chamber, it had been agreed that a letter should be addressed to the Government asking that its influence should be used in favour of effecting a reduction of the present rates. The Board approved this course The Board had also before it a letter from Lloyd's urging the expediency of restoring telegraphic communication with the Fastnet Rock, so that passing vessels might be reported, and information of casualties conveyed to Lloyd's and the various shipping firms interested in the mail steamers which run from America. Proper arrangements have been made with the Commissioners of Irish Lights as to the service, and the rock had been connected with the mainland by Government. It appeared, however, that the Board of Trade, the owner of the cable, did not seem inclined to allow Lloyd's messages to pass, and the efforts of the Chamber were requested to induce the Board of Trade to accord to Lloyd's the necessary facilities. The Board cordially agreed with this application, and decided to support it by a communication to the President of the Board of Trade. The City Council of Manchester passed on Wednesday a resolution authorising the promotion of a local Bill in Parliament next session for the carrying out of various objects. Afterwards a meeting of property-owners and ratepayers was held, at which the action of the Council was submitted for approval or otherwise. The Lord Mayor presided. Strong opposition was forthcoming to a proposal for a clause in the Bill to empower the Corporation to work and demand and take tolls upon the tramways in the city, and to use electric or other mechanical power as a mode of traction thereon. Alderman Sir A. Marshall said the committee which had been appointed to consider the desirableness or otherwise of the Corporation taking over the Carriage and Tramways Company's concern had not yet reported. The Bill did not seek to commit them in any way, but simply empowered them to treat, if it should be decided to approach the company. Mr. Earnshaw one of the leaders of the opposition, said the members of the City Council were already complaining of being overworked in the city's interest. By taking over the tramways they would have to create an entirely new department, and would saddle the ratepayers with the wages of a new set of officials. Other speakers complained that the subject was being thrust upon the ratepayers, and held that as the Corporation went to Parliament every year for a new Act, they could easily wait until nearer the time when the tramway company's leases would fall in. The meeting refused to sanction the proposed clause.

Electric Tramways in London.—Mr. J. Clifton Robinson, A.I C.E, who is widely known on both sides of the Atlantic in connection with matters of tramway management and engineering, writes to the *Pall Mall Gazette*: "I would crave a little of your space to show, in the first place, what has stood in the way of this advance in tramway traction, and thereafter to illustrate its benefits by reference to tramway extensions and conversions in which I have been actively engaged for the past two or three years. The result of extended observation and practical knowledge is my conviction that up to the present time no method of traction has been introduced that is so safe, so economical, and of such universal applicability as the overhead electric trolley system. As regards the obstacle in the way of introducing electric traction into London, the most instructive way I can show this is to give a plain narrative of the facts. In the autumn of 1894 the London United Tramways, Limited, of which I am the managing director, turned attention to the powers granted to their predecessors, the West Metropolitan Tramways Company, under Acts of Parliament passed in 1889 and 1891. These included the reconstruction as double line of the tramway in the Uxbridge-road, between Shepherd's Bush-green and Acton, and my company sought to take advantage of the opportunity when rebuilding this line to introduce the most approved form of electric traction as an object-lesson within the metropolitan area. From various considerations, such as the width and suitability of the roadway, the character of the district, and the opportunity afforded of combining the electric lighting of the road with the working of the new tramway, the company regarded the circumstances as especially favourable, and proceeded to obtain the necessary consents of the local authorities. The assent of the Hammersmith Vestry was unanimously granted on November 14 of last year, after members of the Vestry had visited Havre, as one of the most recent and most easily accessible examples of the adoption of the overhead wire system within a busy city. The Vestry also appointed a deputation of their Works and Electrical Committee to attend the London County Council in support of the company's application. Statements showing fully what was proposed and indicating the extraordinary progress of electric traction in America, on the Continent, and in this country, as well as illustrations of the general appearance of the line then under construction at Bristol, were submitted by me. The matter was remitted to a committee whose report was strongly against the consent being granted, the objections raised by this committee being apparently of an entirely sentimental character. With such a report presented to it it is perhaps hardly surprising that the London County Council refused its consent, though it is a thing to marvel at that the refusal, which was carried by a large majority, was really the act of the so-called 'Progressive' members of the Council, and was based upon such fantastic assertions as that the plan would 'becloud the sky with a metallic cobweb' or that in America surrounding property had deteriorated where electric overhead traction had been introduced. If these objections were well grounded, how are we to reconcile the construction or conversion of 10 000 miles of electric tramways on this system in America within the last eight years? The refusal was given on January 29 last. As, however, illustrations of practical success are of more value than myriads of unfounded objections, I should like to show briefly what has just been done in Bristol, on the basis of my report to the directors, and what is in progress in Dublin, Leeds, Birmingham, Glasgow, and other large cities. The electrical overhead line at Bristol, which was inaugurated on October 14, forms part of the system of the Bristol Tramways and Carriage Company, Limited, founded in 1875, and now comprising a system of 18 miles of tramways. The electric section, four miles in length, consists of two miles of line reconstructed leading from the heart of the city to St. George, and two miles of new line opening up the manufacturing district of Kingswood, the route presenting every possible difficulty, including narrow and congested thoroughfares. Gradients up to 1 in 15 are encountered, and these are surmounted by the electric motor car, trailing an ordinary car, both fully loaded, and maintaining a uniform speed of eight miles an hour without apparent effort or difficulty. The 'trolley' wire is supported at a height of 21ft. from the ground, in some parts by centre standards carrying also the electric light, and in some cases also the gas lamps, and sometimes upon standards at the kerb with an arm or bracket supporting the two wires. The standards are placed at an average distance of 120ft. The best testimony to the success of the installation, apart from the many signs of public appreciation since the opening of the lines, is afforded by the opinions expressed at the inaugural ceremony by Prof. Silvanus Thompson, F.R S, whom everybody will recognise as one of the most competent electricians of his time. On behalf of the gas and water interests of Bristol, Prof Thompson watched the process of construction both openly and by covert visits, and his testimony is that, while the efficiency of the mode of traction is unquestionable, the requirements of the Board of Trade for the safety of the public and for the prevention of electrolysis in the street pipes had been most fully carried out. The Bristol local authorities and the Bristol people fully endorse his views as to the outward appearance and practical working of the new system. A beautifully illustrated pamphlet describing the Bristol installation has been prepared, and to those who cannot visit the city it will show conclusively how futile are the so-called æsthetic objections to the overhead trolley system. Some further practical facts may be stated. On one of the Bristol horse lines, now carrying 2¾ millions of passengers yearly, the loss from lack of speed over this difficult route is calculated to amount to a 'sinful waste of one year in a week.' The

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electric car can double the daily mileage, and thus give twofold the accommodation to the public. The car is fitted with electric brakes by which, independently of the line circuit, the motor-man can stop the car within its own length, even on the steepest descent. The cars are larger and more commodious, they are self-lighted, so to speak, with the electric light at night, and already a quarter of a million of passengers have been carried in safety, and without hitch or delay, despite the disadvantages of opening a new electric system at this season of the year. Outside the power-house, the whole staff of men and boys has been drawn from the ordinary horse-car service, and with a very short training become efficient in the management of the motors."

PROVISIONAL PATENTS, 1895.

NOVEMBER 4.

20790. **Improvements relating to filaments for electric incandescent lamps.** Frank Eustace Wilkins Bowen, 55, Parliament-street, London.

20801. **An improved means for electrically lighting gas jets from a distance.** Oscar von Morstein, 89, Chancery-lane, London. (Complete specification.)

20815. **Improvements in coin-released machines which are electrically driven** Edward Thomas Middlemiss 23, Coleman-street, London.

20821. **An improved reflector for electric arc lamps.** Vincent Fabris, 64, Mark-lane, London.

20824. **Improvements in or relating to electric batteries.** Walter Grimes, 323, High Holborn, London.

20828. **Improvements in or relating to primary electric batteries.** Walter Rowbotham, 45, Southampton-buildings, Chancery-lane, London.

20835. **Improvements in or relating to insulating conduits or tubing and connecting boxes for containing electrical conductors.** Alfred James Perton Whitaker and Frederick Gwilym Treharne, 45, Southampton-buildings, Chancery-lane, London.

NOVEMBER 5.

20843. **Improvements in electric batteries.** Charles Percy Shrewsbury, Frank Laurence Marshall, and John Laskey Dobell 57, Chancery-lane, London.

20883. **Improvements in electric systems.** Philip Middleton Justice, 55, Chancery-lane, London (William H. Nixon, (United States.) (Complete specification.)

20904. **Improvements in controlling electric motors by the three-wire system** James Devonshire, 70, Chancery-lane, London. (William B. Potter, United States.) (Complete specification.)

20905. **Improvements in electrically-driven machinery.** Edward Neville Bray, Heathbourne, Wandsworth Common, London.

20917. **An improved form of electric candle fitting.** Edward Bulstrode, 106, Crofton-road, Peckham, London.

20923. **Improvements in electrical annunciators.** William Phillips Thompson, 6, Lord-street, Liverpool. (Henry Buckner Higgins, United States.) (Complete specification.)

20924. **Improvements in electrical annunciators.** William Phillips Thompson, 6, Lord street, Liverpool. (Henry Buckner Higgins, United States) (Complete specification.)

20925. **Improvements in batteries or compound bells applicable for pocket electric lamps and for other purposes.** Edward Burnet, 6, Lord-street, Liverpool.

20926. **Improvements in block systems for electric railways.** Reginald Belfield 31, High Holborn, London.

20928. **Improved means and appliances for regulating the feed of carbons in electric arc lamps.** James Jeffryes and John Lea, 166, Fleet-street, London.

20940. **Improvements in printing telegraphs.** James Yate Johnson, 47, Lincoln's-inn-fields London. (Jonathan Edwards Woodbridge, United States) (Complete specification.)

NOVEMBER 6.

20986. **Improvements in collecting brushes for dynamo-electrical machines, electrical motors, and other electrical machines and apparatus** John Lenderyon, jun., and John Williams, jun., 7, Staple-inn, London.

NOVEMBER 7.

21045. **Controlling electrical switches.** James Browett and Herbert Arthur Henderson, 4, Corporation-street, Manchester.

21050. **Improvement on the preparation of hydrosulphite of sodium by the electric current.** Leon Marchlewski and Michael Hertz, 25, Wellington-street, Higher Broughton, Manchester.

21090. **Improvements in or relating to welding or joining together metals by electricity.** Herbert Alfred Bessemer, 93, Ritherdon-road, Upper Tooting, London.

NOVEMBER 8.

21137. **Electrical tramway and railway conductors.** George Hinde Nisbett, 8, Quality-court, Chancery-lane, London.

21146. **Improvements in the construction of tubes or conduits for electrical conductors.** Frederick Bathurst and Gustav Binswanger, 88, Queen Victoria-street, London.

21153 **Improvements in or in connection with arc lamps.** Frank Michael Lewis, 30, Park-row, Leeds.

NOVEMBER 9.

21283. **Improvements in the electro-depositing of metals.** Alexander Stanley Elmore, 28, Southampton-buildings, Chancery-lane, London. (John Oliver Surtees Elmore, India)

21297 **Improvements in automatic electric arc lamps and automatic cut-outs.** George Henry Church, 2, Lancaster-place, Strand, London.

SPECIFICATIONS PUBLISHED.

1888.

11897. **Electric current indicator.** Shallenberger. (Second edition)

1894.

2806. **Electrolytical decomposing apparatus.** Kellner. (Second edition.)

19605 **Electrical conductors.** Andrews.

20152. **Incandescent electric lamps.** Fabris.

20382. **Electric telephones.** Brown and Neilson.

22029. **Electrically-propelled fans.** Pickup and Hindle.

22197 **Recording telegraphic apparatus.** Damaskinos.

24369. **Electric bells.** Brierley.

24551. **Electricity meters.** Collinson.

24796. **Electric igniting apparatus.** Findenigg and Schwartz

24926. **Dynamo-electric machines.** Blackburn and Buchanan.

25340 **Electrical decomposing tanks.** Leith and others.

1895.

4119. **Electric contact strips.** Horvath.

17249. **Gauging electrical wires, etc.** Woodhouse.

17287. **Insulators for telegraph, etc , poles.** Dibb and Vickers

17288. **Electrolytic decomposition of alkaline salts.** Rosenbaum.

17442. **Electric resistances.** Stephens.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6½
Brush Company, Ordinary	3	1½-1⅝
—— Non. Cum., 6 per cent. Pref.	2	1⅞-2⅛
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5⅛-5⅜
Chatham and Rochester	—	*
Chelsea Electricity Company	5	6⅞-7⅛
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	12⅛-13⅛
—— 6 per cent. Cumulative Pref.	10	16-16½
—— 5 per cent. Debenture Stock	100	131-135
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	132-134
—— 5 per cent. Pref. Shares	10	14⅞-15⅛
County of London and Brush Provincial Co., Ordinary	10	8⅛-9⅛
—— 6 per cent. Cum. Pref.	6	8⅞-9⅛
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅛-2⅛
Edison and Swan United Ordinary	3	1⅞-2⅛
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	¾-1
—— 7 per cent. Cumulative Pref.	2	2-2½
Elmore's Copper Depositing	2	⅝-⅞
Elmore's Wire Company	2	¾-1
Fowler-Waring Cables	5	⅛-¼
W. T. Henley's Telegraph Works, Ordinary	10	14-14½
—— 7 per cent. Preference	10	15½-16½
—— 4½ per cent. Debentures	100	108-111
House-to-House Company, Ordinary	5	4⅛-4⅜
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	19-20
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge Ordinary	5	8-8½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅞-8⅛
Liverpool Overhead Railway	10	11⅜-11⅞
—— 5 per cent. Pref.	10	15⅛-15⅝
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric Supply	5	⅜-½
Metropolitan Electric Supply	10	10-11
—— 4½ per cent. First Mortgage Debenture Stock	100	117-120
National Telephone, Ordinary	5	5⅜-6⅛
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15½-16½
—— 5 per cent. Non. Cum. Third Pref.	5	6⅛-6½
—— 3½ per cent. Deb. Stock	100	105-107
Notting Hill Company	10	8½-9½
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7½-8
—— £4½ shares	4½	6¼-6¾
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-105
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8-8½
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	40-42
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4⅜-5
Westminster Electric Supply, Ordinary	5	8-8½
Yorkshire House-to-House	5	6½-7

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NOTES.

Electro-Harmonic Society.—Electro-musicians are reminded that it is ladies' night on Saturday, November 30, at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., at eight o'clock.

"Autocars" in Scotland.—A Glasgow engineer, Mr. George Johnston, the inventor of a mechanical tramcar, is now running an "autocar" in the streets of that city. It is stated that this is the first horseless carriage to be seen on the other side of the Border. The motive power of the conveyance is not stated.

The Cleveland Accident on Saturday last was a terrible affair, but the fact that electricity was the motive power of the unfortunate car of course had nothing to do with the disaster. It seems incredible that even carelessness should be allowed to be responsible for a driver or a conductor of a car imagining that a drawbridge was in place when it was not, and plunging so many people into a watery grave.

Telephones in Collieries.—At the last meeting of the Midland Institute of Mining, Civil, and Mechanical Engineers at Sheffield, Mr. A. R. Bennett read a paper on "Telephonic Communication in and about Coal-mines." While not disparaging any of the systems now in use, he suggested, to avoid the use of an exchange in a colliery, that several insulated wires might be braided together into one cable, that each station might have the means of communicating with any other station independently of an exchange.

The "Booster" System.—In case there should be an electrical engineer who is not by this time thoroughly posted on the subject, it may not be amiss to state that the "Booster" system consists in the introduction into a feeder, and in series therewith, of an additional E.M.F. to compensate for the loss of voltage on the said feeder. Usually this is accomplished by a generator whose voltage is made to vary with and adapt itself automatically to the varying loss on the feeder by causing its fields to be excited wholly or partially by the varying current on the feeder.

Phosphorescence after the Passage of an Electric Discharge.—Some recent experiments have been made by a French scientist, M. Seguy, on the phosphorescence of rarefied nitrogen after the passage of an electric discharge. He found that nitrogen in the presence of a metallic bichloride (stannic chloride, for example), phosphoresces like oxygen after an electric discharge. The light emitted during the discharge is pink, and the phosphorescence milky white, of greatest intensity immediately after the break of the current, and gradually diminishing until it disappears at the end of from 10 to 80 seconds.

Light Railways in Germany.—As evincing the interest which has for a comparatively long period been taken in Germany in the construction of secondary railways, it may be noted that since the beginning of last year the Minister of Public Works in Prussia has issued a monthly publication on light railways—the *Zeitschrift für Kleinbahnen*. The October number contains a map of all the existing and proposed light railways in Belgium, and also publications of English, French, and German works issued from time to time since the September number was published. It is well illustrated, and is published by Herr Julius Springer in Berlin.

Hawking Incandescent Lamps.—According to the *Financial Post*, the London pedlars have taken to hawking electric incandescent lamps. This paper says, "Although the gas interests persist in asserting that the electric light is a luxury, and that there is no chance of its becoming popularised in the wide sense, it is a sign of the times, as one learns from a police-court charge, that a street hawker—and street hawkers are a shrewd class—should consider it worth his while to buy electric incandescent lamps and display them on a barrow for sale in the thoroughfares." Perhaps (our contemporary the *Gas World* suggests) the hawker was selling the bulbs as a new kind of air balloon.

Edison's Retaining Fees.—A month ago Mr. Edison was notified by Mr. C. A. Coffin, president of the General Electric Company, that his retainer fee of 400dol. a week would be discontinued at once, but that if he (Edison) were in need of money the same sum would be advanced to him every week and charged to his account. Thomas Alva did not accept the situation cheerfully. He at once called on Messrs. J. P. Morgan and Co. and "expressed himself with some emphasis." It was finally decided, it is stated, to place him upon the pay roll of the Edison Illuminating Company of New York for an equivalent amount "for services rendered in years past."

City and Guilds of London Institute.—We gather from the report for the session 1894-95 of the City and Guilds Technical College, Finsbury, E.C., that during the session 210 day students have been in attendance, of whom 95 were in the electrical department, 59 in the mechanical department, and 56 in the chemical department; while of these 210 day students 159 reside in London and suburbs, 49 come from outside a radius of 10 miles from London, one from Canada, and one from Holland. The past students of the two engineering departments—electrical and mechanical—show a good record of subsequent successes. With regard to the evening classes at the college, 1,119 tickets have been sold to 926 individual students, compared with 1,091 tickets sold in the preceding session to 922 students.

Telegraphing in Tunnels.—Mr. R. S. Culley, of Weston-super-Mare, remarks that it is interesting to see how supposed electrical impossibilities recur to the imagination of the public. A statement has been recirculated that it was found impracticable to send a telegraphic message through the Hoosac Tunnel, 4½ miles, even by means of a well-insulated wire, apparently because of iron ore present in the rock. He writes: "Now about 45 years since, the Sheffield and other local papers attributed the difficulty of signalling through the Woodhead Tunnel—Sheffield and Manchester—to a similar cause, the supposed existence of iron ore, whereas, of course, the only reason was the bad insulation of the wires. I recollect the case well, as I had to spend several Saturday nights and Sundays in the tunnel—a little over three miles long—to put matters right. In that case, as in the Hoosac instance, the wires were eventually carried overland on poles, simply because this was cheaper than properly-insulated wires through the tunnel."

A Safety Appliance for Live Wires.—Mr. A. E. Hutchins, of Detroit, has patented a method of cutting out live wires carrying heavy currents which seems to possess several meritorious features, and which, in view of the Board of Trade discussion this week, is vested with opportune interest. A ground wire is attached to the pole supporting the wire, and this ground wire is connected with a metallic plate or pipe buried in the earth. The upper end of the wire attached to the pole is connected with a specially-made insulated metallic bracket in the form of a crotch or fork. Just above this bracket the line wire is bared for a few inches. If an accident should happen, causing a break in the line wire, it would fall to the ground, the bare place would come in contact with the crotch in the bracket, and the heavy current would be diverted through the wire on the pole to earth. Mr.

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Hutchins states that he has handled with perfect safety a line wire carrying a current of 3,000 volts when the pole was equipped as described.

The Electric Athletic Association.—The annual conversazione and distribution of prizes in connection with the Electric Athletic Association took place last Friday evening at the Holborn Town Hall. The Duke of Norfolk, Postmaster-General, who was received by a guard of honour of the Post Office Rifles, distributed the prizes and was supported upon the platform by the following officials of the Post Office and Telegraph Department: Mr. Spencer Walpole, Mr. H. C. Fischer, Mr. E. May, Mr. J. Eames, Mr. J. Hookey, Mr. J. Hill, Mr. C. T. Fleetwood, Mr. H. Preece, Mr. J. C. Lamb, and Mr. J. R. Langton. At the conclusion of the distribution, Mr. Spencer Walpole proposed a vote of thanks to the Duke of Norfolk, and remarked that the presence of his Grace that night was an assurance of his sympathy with the great staff of the General Post Office.

An Automatic Mercurial Air-Pump.—A mercury air-pump, somewhat akin in principle to Geissler's, and which may be called a reservoir pump, is described by Herr F. Neesen in *Wied. Ann.* It is worked by an auxiliary water-pump, the mercury being raised and lowered in the reservoir by the automatic motion of two valves, which allow the mercury in the cistern to be exposed to the atmospheric pressure or freed from it by the action of the auxiliary pump. The peculiarity of the automatic valve motion is that the valves are moved by a system of floats, of which one part varies its weight by admission and recess of mercury, so that there is the necessary difference of level in the cistern between the phases of valve opening and closing, corresponding to whether the mercury is rising or falling. The adjustment for preventing too rapid rise of mercury as the pressure falls below 1mm. is made by withdrawing a little mercury from the cistern into a side vessel. The author describes an arrangement with a tap instead of valves, the difference of phase in action being effected by an automatic variation of the leverage acting on the tap.

Prof. S. P. Thompson at Toynbee Hall.—Prof. Silvanus P. Thompson delivered the Saturday popular lecture at Toynbee Hall, East London, last week, choosing for his subject "The Magnetic Effects of an Electric Current." An electric current, he said, could produce magnetic effects, and electricity applied to a coil of wire made a magnet, but what was the relation between magnetism and electricity was a mystery which had yet to be solved. We wonder if Prof. Thompson has met the author of a work on "Magnetism: Its Potency and Action, with Suggestions for a New Cosmography and a New Celestial Geography," who gives the following definition of magnetism: "Magnetism is the connecting link between mind and matter, or rather the medium by and through which the Divine energy is imparted to all matter, and the primary exhibition of this energy is an exercise of God's will. The Deity is the omnipotent magnet. Electricity is condensed magnetism, and electricity, light, heat, gravity, sound, capillary attraction, repulsion, attraction, disruption, and explosion are modifications of magnetism, and are influenced by it."

Electrical Editors and Matrimony.—"Wetzler—Gerson.—At Delmonico's, Fifth-avenue, on October 30, Mr. Joseph Wetzler, editor and vice-president of the American *Electrical Engineer*, was married to Pauline, daughter of Mr. Jacob Gerson, of New York." Mr. and Mrs. Wetzler will please accept our congratulations. The journal *Electricity*, which, like Mr. Barnes, is of New York, remarks reflectively upon the happy circumstance: "The list of electrical newspaper men who have shown their wisdom and stability during the last year or two includes Messrs. Kreidler, Keily, F. L. Perry, Nelson W. Perry, Wetzler, and Montgomery. The only hesitant remaining, so far as we know, is Mr. W. D. Weaver, of the *Electrical World*. We trust Mr. Weaver may soon be brought to a realising sense of his unfortunate position and find a wife. Perhaps not the only, but certainly the biggest, cranks in the world are old bachelors and old maids—and the latter are not to be blamed, because they would not be so if every man did his duty. The community now waits for Mr. William Delinquent Weaver." We are puzzled to account for this apparent matrimonial reluctance on the part of American electrical journalists, unless it be that they imagine that there is some truth in the saw which says that while those whom the gods love die young, those whom the imps favour marry young.

New Railway and Tramway Permanent-Way Scheme.—Mr. W. H. M'Neight, of Dublin, has given demonstrations of "some inventions which are the result of 14 years' thought and labour, and which, if brought into practical use, will probably cause a remarkable change in the methods employed of laying down the permanent ways of railway and tramway systems. Expense is saved by dispensing with all the nuts and half the bolts at present used, but, what is more important, the tendency of the rails to get out of the straight is altogether avoided." Mr. M'Neight thus describes his methods as relating to railways: "Two powerful bolts with flanges on one end pass through the extremities of the connected rails and plates. At the other end of each bolt is a wedge-shaped mortice through which passes a wedge. The narrow ends of the two wedges face each other. They are connected by a bar with screw threads running in the ordinary direction at one end and in the opposite direction at the other end. When the screw bar is rotated it draws the two wedges together, and thus the plates can be tightened better than at present, while nothing but a reverse motion of the screw can by a hair's breadth alter the position." The plan for dealing with the permanent ways of tramcars is claimed to be even more simple and effective. "The chair is so constructed that the wooden wedge driven through it and the rail cannot leave its position unless taken out by a hammer, nor is it affected by changes of temperature." Mr. M'Neight's plan of laying tramway rails is one of dovetailing. When the transverse rails are put in their place, the rails are at one and the same time connected and gauged, and so kept in their position until the sets are put in. The usual allowances are made for contraction or expansion.

Cable Schemes.—At the private interview at the Colonial Office on Tuesday with the Agents-General for the Australasian and other colonies for the purpose of discussing the projected Pacific cable which it is proposed shall pass entirely through British territory, Mr. Chamberlain is stated to have observed that such a meeting was, in a sense, a meeting of the council of the Empire, brought together for the purpose of common interest, and that the presence of the representatives of the Cape and Natal, who were not concerned in the project in its present form, was an evidence of solidity and sympathy. He expressed his opinion that the project showed a very fair prospect of remuneration on the capital required, and his willingness to join in the formation of a joint commission which should report upon the subject. He also suggested that the commission should be formed consisting of representatives of Great Britain, two from Australasia, and two from Canada. After some discussion, it was arranged that the Colonial representatives should be named by the Colonial Office and appointed by the

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Imperial Government, and that the commission should consider and report on the whole subject in all its aspects; and it was understood that the Agents-General and the High Commissioner for Canada would move their respective Governments to appoint representatives. It is stated that the Canadian Government is negotiating for the extension of the telegraphic service to Belle Isle, *vid* Bonne Bay, Newfoundland. This line would be of great benefit to shipping interests, as it would enable vessels from England to be reported the fourth day out.

Electricity on the Brooklyn Bridge.—We have already announced that the officials of the Brooklyn Bridge have requested the manufacturers of electric railway apparatus to submit bids for an electric system for switching the cable trains at the terminals. The specifications call for the equipment of each train with electric motors of sufficient power to move the train from the point where it leaves the cable on the incoming track to the point where the cable is gripped on the outgoing track. The overhead system will probably be employed, as the conditions are such that aerial wires can be strung at a small cost. One car of each train will be equipped with motors, and controllers will be located on the front and rear cars, so that the train may be operated from either end. During the trial of the electric system the current for operating the motors will be taken from the trolley wires of the Brooklyn City Railway. The switching at the terminus is at present done by steam locomotives. During the busy portions of the day about 75 trains an hour are operated, and considerable time is lost in making connections between the trains and switching engines. The adoption of the electric system will relieve the passengers of the disagreeable noise and smoke of the steam locomotive, and, it is believed, will greatly facilitate the handling of trains. The work will be pushed rapidly as soon as the contract is awarded. The construction of the new terminal stations is being prosecuted as fast as possible, and when completed, and the electric switching system is in operation, the inconvenience to which passengers are at present subjected will, it is thought, to a very great extent disappear.

Telegraphy in Western Australia.—There is great grumbling in Coolgardie just now on account of the alleged inadequacy of the telegraphic arrangements. It seems strange that a go-ahead country like "Westralia," whose population is at present growing by leaps and bounds, should apparently neglect to keep pace with the times on so important a question as that of providing telegraphic facilities. At any rate, an enthusiastic public meeting has been held in the Theatre Royal at Coolgardie for the purpose of considering what steps should be taken to improve the post and telegraph arrangements for the town and district. The Mayor presided, and the platform was occupied by the leading citizens of Coolgardie and Kalgoorlie, those from the latter place coming in specially to take part in the meeting. Mr. Thompson, chairman of the Chamber of Mines, moved that the meeting "strongly condemns the inactivity and apathy of the Government in not providing and maintaining a telegraphic service more nearly suited to the present and rapidly-increasing requirements of the field." Coolgardie, he said, would soon be second in importance to no town in the colony, and all the other portions of the district were also growing with great rapidity. The goldfields were united in their demands, and the Government was very foolish in attempting to resist them. Mr. Whittenoon seemed willing to do what he could, but Mr. Sholl, the Postmaster-General, was a stumbling-block, and it would be a good thing for the country if Mr. Sholl were persuaded to retire on full pay. This bold motion was carried unanimously. Mr. Howard Taylor next moved that, in the opinion of the meeting, it was absolutely necessary that the telegraph line to Perth should be duplicated at once, and a double line to Esperance be completed as early as possible. If the reasonable requests of the goldfields were not granted, he expected to see a large number of residents of Coolgardie about Christmas time hold the biggest meeting in Perth that the colony had ever seen, and beard the Forrests in their den. This resolution was also adopted. The Government of the colony must look to it that it does not belie the watchword of the island continent—"Advance, Australia!"

The Denayrouse Gas-Electric Lamp.—Attention is again being attracted to the scientific toy known as the Denayrouse lamp. It may be remembered that at the last annual meeting of the French Gas Institute M. Mallet said that he was happy in bringing under the notice of the society a "wonderful invention" of his friend M. Denayrouse, to which reference had been made a short time ago by Prof. Vivian Lewes at the Gas Institute in Edinburgh. M. Denayrouse had been struck with the idea of "blowing" the Welsbach burner, and this he did in a peculiar way. He mixed the air with the gas by the aid of an "almost insignificant" current of electricity, and secured absolutely unexpected results. In his lamp there was a metal receptacle, a small electrical motor, and an incandescent mantle. As they would see from the lamp shown them, the light was very intense, of a power of 35 or 40 carcels, and the lamp had a consumption of seven litres per carcel. The No. 2 lamp had a power of 80 carcels and a consumption of two litres per carcel. As they were now able to judge of the intensity of the light, he would explain the method of blowing. Inside the spherical lamp were two small accumulators, a tiny dynamo, and a fan. The energy developed by the motor was 1·3 volt and $\frac{1}{10}$th ampere. This set the fan in rapid motion, causing the air to ascend through the gas mantle like a blow-pipe. People might be inclined to say that the lamp was no doubt interesting, but somewhat complicated. There was indeed no inconvenience whatever, for with the almost general employment of electricity in their homes, the lamp would be reduced to the greatest simplicity. It also possessed another advantage, in that the lamp could be lighted automatically. M. Mallet, continuing, said that he thought in time the lamp would be able to compete with the arc lamp, not only in price, but also in intensity, for it was rare to see an arc lamp of 80 carcels. He thought that the arc lamp would have to "descend from its pedestal." The inventor of the lamp, M. Denayrouse, himself, however, is very wisely not so sanguine as his prophets. He certainly says that they do a great deal with an infinitely small quantity of electricity and a lot of gas, and they do it better than with electricity alone, and that instead of gas and electricity being enemies they have made them sisters, but as to the practical working of the lamp he will say nothing.

"Roundabout Notes in Electrical Europe."—Mr. E. J. Wessels brings to a conclusion his series of articles with this title in the New York *Electrical Engineer*. He visited 32 European cities in 54 days, so that his work was essentially hurried. He winds up with a generalisation which was doubtless exclusively intended for American electrical engineers, but which may prove interesting, and possibly wrinkle-giving, to electricians on this side. It is not, of course, necessary to agree with all his statements. He says: "It was gratifying to notice that there were very few things in use on electric roads abroad which can be employed advantageously here. This may seem like undue praise of our American manufacturers, but I believe

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it to be true, and for corroboration need only mention the fact that the eyes of Europeans are constantly turned towards America, and that they watch developments here with eager interest. Some of them have their 'pickets' in our shops and on our roads, and thus are kept advised on our practice. . . . Several prominent officials informed me they took these [American] papers home, so they would not miss any of the contents. They regretted that business pressure prevented them from reading them in their offices. Those who couldn't read English had the principal articles translated. In Europe, representative men award the palm for progressiveness in the art to us here. These gentlemen are ready, therefore, to adopt anything we have which proves practicable for their use. There are difficulties in the way of building up foreign trade, but they are not insurmountable. It may be stated that correspondence should be conducted exclusively in the language of the country with which business is desired. In numerous places in Germany a letter written in English would not receive attention, while if it were written in German it might lead to business. To develop trade, it is essential that American houses should 'keep everlastingly at it.' They should send their literature to the various roads and open correspondence, calling attention to anything new. If the article be of real merit and adaptability, it is not likely to be long before a trial order will follow. That trial order will lead to large business. In view of the heavy duty and freight on many parts of equipment, it is desirable that, as far as possible, apparatus should be shipped 'knocked down' and in sections, and sometimes if 'unpainted' there will be a decided reduction in tariff. It will be a wise plan to secure good resident agents who will take pains to keep prospective buyers posted. Their efforts should be supplemented by forwarding literature from America. Apparatus intended for shipment abroad should certainly be patented. If patented, there is some chance of protection, but if unpatented, the sending of a trial order will only open the door still wider for infringement."

Electric Fire Hazard.—Mr. Ludovic MacLellan Mann writes upon the subject of fire risks incidental to the lighting of paper-mills. With regard to the use of incandescent electric lamps, he remarks that the top surface of the bulb in the dry department of the mill is apt to become thickly coated with fluff and dust, and that such a deposit upon the heated surface of the glass is dangerous and should be prevented from forming by placing the lamp in an outer glass globe arranged to exclude dust; and as to arc lamps, in order to decrease the risk of the emission of particles of incandescent carbon and the dropping of melted copper, the lamps should be enclosed at the base. This means of safety ought, Mr. Mann says, to be carried into execution in the wet as well as in the dry portions of paper-mills. Where the objectionable practice prevails of dispensing with globes for arc lights (as happens occasionally where ceilings are low or when it is found shadows caused by defects in the glass of the globes hinder the scrutiny of pulp), the lights should be provided with carbon-catching saucers or trays of large size and considerable depth. Unless where wet processes are carried on, naked arcs should be prohibited. As particles of carbon have, he continues, been seen to pass out even through the top openings of arc lamps, the complete enclosure of the lamps is desirable where loose sheets of spoiled paper, unboiled esparto, straw, heaps of rag fluff, and any other light dry materials are lying about, and where cutting and dusting are performed. A reasonable suggestion is that the aperture at the top of the globe of every arc lamp in the dry-process rooms be fitted with some kind of wire gauze of simple form—such as a piece of used-up paper-machine wire—always easily obtainable. Lighting-up might be made a less frequent cause of fire in gas-lighted mills which are dusty and contain inflammable stocks if that handy contrivance the electric spark-producer were oftener used. This cause of disaster is of course not a possible one in mills lighted entirely by electricity, and herein Mr. Mann sees a point in favour of the electric illumination of paper-mills. The question of the comparative profitableness in the long run of each illuminant really hinges, he thinks, upon the degree of soundness and appropriateness with which electric light installations are put in. It thus behoves the electrical engineer for his own sake to turn out only good and suitable work for his friend the paper-maker. Wiring and fittings in nearly every style are liable to injury by the incessant vibration which goes on in a paper-mill. A premature wearing away and loosening of parts together with corrosion and damp cause leakage of current and occasion frequent repairs. It is consequently found that some paper-mill owners are dissatisfied with their electric lighting installations. Mr. Mann therefore emphasises the necessity of good workmanship and good material. Chlorine gas may be styled the arch-enemy of electric light installations because of its pernicious effect, when moist, upon wood, metals, and other substances used for protecting wires. In the course of time it rots woodwork and corrodes all save some of the rarer metals. The pulp and bleach liquor tanks are the places to which chlorine gas is intended to be confined, but it cannot be prevented from escaping and diffusing itself throughout the atmosphere of the wet department and even in many instances of the dry-process rooms. Experience suggests the suitability for paper-mills of the concentric system of wiring with its lead-enveloped conductors. As it is found, however, that even lead, after an exposure of many years, will become damaged in a moist and chlorine-laden atmosphere, it might be well to run through gas-piping the lead-covered conductors used in the concentric system, and to employ junction-boxes of a low grade of cast iron. Moreover, rats, so numerous in most paper-works, would by this means be prevented from gnawing the lead of the conductors. It is a matter of the first importance to be able to resist the chlorine corrosion referred to. Varnishes may be discarded as unsatisfactory. Use might be made of the property possessed by lead chloride to form insoluble sulphate of lead in the presence of dilute sulphuric acid or solutions of soluble sulphates. Protection might therefore be secured were the lead sheathing in exposed situations wrapped in, say, asbestos cloth or felt well saturated with a solution of some soluble sulphate. The doctoring of the lengths between joints is, however, not so vital a matter as giving attention to the joints themselves. Water-tight, fire-proof junction-boxes are to be strongly recommended. One method of wiring suggested for paper-mills is to have the insulated conductors suspended from beam to beam and supported by rubber hooks or by porcelain insulators at each resting place. The objections to this system are that the wiring and supports are apt to become injured by the moving about of ladders when repairs are in progress and by the vibration of machinery. The most natural and convenient place for a dynamo is in or near the engine-house. This is also the safest position where, as is arranged in all well-appointed mills, the engine-house is outside the mill premises. In conclusion, Mr. Mann says that, given an installation put up soundly and after the styles indicated as trustworthy, and a competent engineer in charge of the machinery producing the light who is always ready to replace broken lamps and to do repairs of all kinds and to make frequent tests, the electric fire hazard may be reduced to a minimum.

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THE QUALITIES OF MANGIN AND PARABOLIC MIRRORS.

We have received from M. Jean Rey the following letter in reply to that of Mr. Nerz in our issue of August 2 last. Though we propose to continue to deal with this subject, which is one of national importance from a military and naval point of view, we regret that we cannot afford space for any further correspondence:

"I trust your readers will pardon me for continuing the discussion on projector mirrors, but Mr. Nerz's letter in your issue of August 2 forces a reply. In the course of the only conversation which I have had the pleasure of having with Mr. Nerz, I well remember that he characterised the invention and production of the Mangin mirror as having been '*the* great step in electric searchlighting, which can be compared to the introduction of rifled guns for artillery purposes.' Such an expression from so great an expert is well worthy of note.

"With regard to the Toulon experiments, I am unable to quote from an unpublished report, but in a statement appended to the French Naval Budget for 1896 will be found the following: 'It is quite possible to make certain with regard to the defence of our ports and of their entrances by means of submarine mines and of searchlights. Comparative experiments recently carried out with the greatest impartiality between the searchlights employed in our ports and the parabolic projectors used by several foreign navies have proved the superiority of our own material.'

"I now propose, firstly, to show that parabolic glass mirrors are quite unsuited to military requirements; and, secondly, to examine the value of certain theories put forward in their favour. In my last letter I referred to the fact that 50 per cent. of the 90cm. × 42cm. Schuckert mirrors, in an important European coast fortress, had perished from concussion and overheating, but I have recently ascertained on good authority that in the fortresses of a mountainous country it has been found that Schuckert mirrors get fractured when in the neighbourhood of heavy guns. Nobody familiar with the manufacture of glass can be surprised at the frequent breakage of thin pieces of convex glass. It is the initial bending of the glass on a mould when hot which weakens it, and which subsequently brings about its fracture. My firm has had great experience with this very class of construction during the last 70 years. We not only made the first parabolic mirrors in 1856 for use in Foucault's telescope, but have also since made a great number of other thin glass reflectors, and we know from experiment that they will not stand the concussion of heavy guns.

"Turning now to the question of the degree of accuracy obtainable in the manufacture of parabolic mirrors, I must confess that I fail to understand Mr. Nerz's explanation of the 7mm. limit, which was the smallest which a Government was able to insert in their specification. I note that Mr. Nerz aims at providing different focal lengths for the separate zones of his mirrors, but I fail to see that any reasonable rule is followed in fixing these focal lengths. Quite recently I attended some curious and interesting experiments made with a 90cm. × 42cm. Schuckert mirror belonging to a foreign Government. The method employed was a strict one, and the focal lengths came out as follows:

Zone	90cm. to 80cm.	diameter	415·9mm.
„	80cm. to 70cm.	„	418·2mm.
„	70cm. to 60cm.	„	420·9mm.
„	60cm. to 50cm.	„	420·9mm.
„	50cm. to 40cm.	„	421·2mm.
„	40cm. to 30cm.	„	421·9mm.
„	30cm. to 20cm.	„	422·2mm.
„	20cm. to 10cm.	„	424·0mm.

"The maximum difference between these readings is 8·1mm. Such a mirror cannot be said to be paraboloidal; it is merely a pseudo-paraboloidal mirror.

"In various publications, Messrs. Schuckert and Co. have repeatedly argued that the parabolic mirror is superior to the Mangin mirror, as the former is constructed with a shorter focal length than the latter (*vide* an article by Max Braun in the *Neue Militarische Blatter* of Berlin, 1888, p. 370; the July number of the *Elektrotechnische Zeitschrift*, 1890, p. 372; also the *Zeitschrift des Vereines Deutscher Ingenieure*, No. 33, of August 13, 1892, p. 957). It is only recently that in the *Elektrotechnische Zeitschrift* of July 5, 1894, p. 367, Mr. Nerz sets aside the influence of the focal length upon the illumination of the objective. The terms he employs, however, are not properly defined, and the reader is led to confuse the luminous flux utilised, with the actual illumination of the objective. It does not follow in the least that an optical apparatus making use of a greater flux should produce a stronger illumination. Thus it is said by Mr. Nerz that a 60cm. × 25cm. Schuckert mirror receives a luminous flux twice as great as that received by a 60cm. × 42·5cm. Mangin mirror, but he omits to state *that the illumination of the objective remains the same in each case.* The focal length merely influences the compass of the beam, and it is not always desirable from a military point of view to increase the compass by shortening the focal length.

"Mr. Nerz's theory is exposed in the article in the *Zeitschrift des Vereines Deutscher Ingenieure* above quoted. To simplify the problem, he supposes the source of light to be spherical, and he seeks the flux received by the mirror. From this quantity he deduces a certain mean illumination by introducing the mean radius vector of the paraboloid, and he, nevertheless, then supposes that the value of this mean illumination is that of the sectional area of the beam at its issue from the reflector. With this hypothesis he calculates the illumination of the sectional area at any distance, and then compares it to the direct illumination of the same surface by the source without a reflector. He thus obtains an expression for the 'condensing power.' The formula, however, is not exact. In the first place, the hypothesis is not correct; and, in the second place, he confuses the *illumination* (or ratio of a flux to a surface) and the *intensity* (or ratio of an elementary flux to the solid angle it contains); thirdly, the supposition that the illumination of the sectional area of the beam is uniform, is in opposition both to theory and to practice. These three errors vitiate all the above arguments.

"Admitting, for the sake of argument, that the source is spherical, and that it produces a homogeneous flux, the illumination of the sectional area of the beam of diameter 'F,' at a distance 'e^1,' (I use Mr. Nerz's notation) can be immediately deduced. It is the quotient of the total flux received by the mirror, by the area of the circle, F—that is, it is:

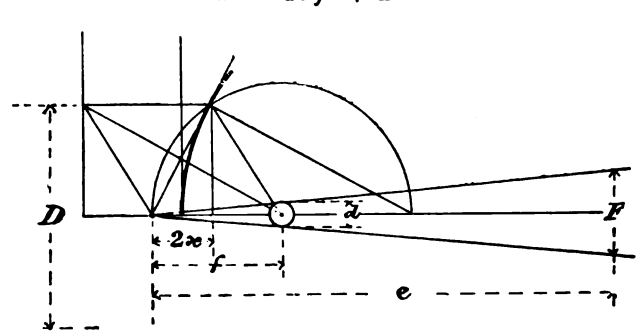
$$4\pi \mathrm{I} \times \frac{x}{f+x} \div \frac{\pi \mathrm{F}^2}{4} = \frac{16\,x\,\mathrm{I}}{\mathrm{F}^2(f+x)} = \frac{\mathrm{D}^2}{e^2 d^2} \times \frac{16 f^2}{16 f^2 + \mathrm{D}^2} \times \mathrm{I},$$

where f = focal length;
$2x$ = sub-tangent;
F = diameter of circle illuminated;
D = diameter of mirror;
d = diameter of crater;
e = distance of illuminated circle.

Note.— $$x = \frac{\mathrm{D}^2}{16 f} \text{ and } \mathrm{F} = \frac{e\,d}{f}.$$

"The ratio between this illumination and that the source of light would produce directly without the reflector—viz., I/e—gives the exact expression of the 'condensing power'—viz.:

$$\frac{\mathrm{D}^2}{d^2} \times \frac{16 f^2}{16 f^2 + \mathrm{D}^2}$$



I say, the exact expression, insomuch as the hypothesis is so itself. This expression includes the focal length, and

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the illumination would be a function of it. The value found by Mr. Nerz, though not exact, is also a function of the focal length, because of the '$\cos^4 \frac{\delta}{4}$' which it contains.

"Unfortunately for all these calculations, however, the hypothesis is false; the light is not homogeneous, and the source is not spherical, and an expression for the '*condensing power*' which would depend upon the diameter of the crater is not supported by facts either for the Mangin and parabolic mirrors or for any other optical apparatus. It is now known that the only factors which enter into an expression for the luminous power of a reflector are the area of the reflector and the intrinsic brilliancy of the source. The intrinsic brilliancy of the crater of the voltaic arc is sensibly constant, and the reflector simply reproduces it at everyone of its points. The fundamental error of the theory of 'condensing power' comes from the supposition that the illumination of the beam is uniform. Such uniformity does not exist. All beams produced by optical instruments are composed of two zones—the first central, more or less extended, with constant illumination; the second around the former, with illumination decreasing from the centre to the edges. The *luminous power* is but the intensity measured in the central zone at unit distance from the projector.

"It is easy to see that the illumination of the beam cannot be uniform. Each part of the mirror produces a cone of reflected rays; the angles of these cones become less and less as we approach the edge of the mirror. The total beam is the result of the superposition of these different cones. This shows the difference between 'condensing power' and 'luminous power.' The luminous power is a physical quantity measurable in any given beam. The condensing power is a mean value of a fictitious nature, and is not applicable to any part of the beam. Colonel Mangin fully recognised these principles, but, curiously enough, Mr. Nerz brings into the value of the 'luminous power,' not only the diameter of the crater, but also a certain mean spherical luminosity, which has no true significance, as the arc does not produce a homogeneous flux. M. Blondel, in his 'Theorie des Projecteurs Electriques,' has treated the theory of brilliancy very clearly, and the consequences of his treatment are simple. The luminous power does not increase either when the focal length is diminished or when the current is increased, always provided that the reflector is aplanatic and that due regard is paid to the cone of shade thrown by the negative carbon, and which varies according to the position of the amp.

"Now, Mr. Nerz clings implicitly to these clear realities in his table of powers of the Schuckert searchlights given by him in the *Elektrotechnische Zeitschrift* for July 5, 1894, and though his table purports to be calculated by the help of the former hypothesis of a spherical mean, his figures, strange to say, justify the theory of brilliancy, and are in contradiction to his formulæ. Thus we see that the three parabolic mirrors of 90cm. diameter, with focal lengths of 31cm., 38cm., and 42cm., have the same 'power'—viz., 61,000,000 candles. Now, $\cos^4 \frac{\delta}{4}$ represents for these three types ·628, ·713, and ·765 respectively, and we should obtain for their luminous powers the values of 61,000,000, 66,000,000, and 73,000,000 candles respectively. This is taking as correct his values for 'd' and 'I_8.' It is clear, therefore, either that Mr. Nerz's formulæ are correct and his figures wrong, or that his formulæ are unsound and his figures based on more rigid principles. In either case, the results obtained in practice do not agree with the consequences of true theory.

"With regard to the question of absorption, Mr. Nerz estimates the efficiency of the parabolic mirror as 90 per cent. This ratio is too great when one takes into account the losses at the entry of the rays into the glass, at their issue from the glass, and the absorption of the silver itself, which, under most favourable circumstances, amounts to 10 per cent. In M. Blondel's treatise, 'On the Determination of the Mean Spherical Intensity of Sources of Light,' will be found a remarkably exact and simple method of measuring efficiency. Two descriptions of measurement only in each case are sufficient, and these I have made for a Mangin mirror of 90cm. diameter and of 45cm. focal length, with edges 70mm. thick, and for a parabolic mirror of 1m. diameter of 40cm. focal length and 7mm. thick. These two reflectors were both in identical conditions of perfect polish and silvering, and were illuminated by a 120-ampere horizontal lamp. The series of observations gave results which agreed well together. The Mangin mirror came out with an efficiency of 85·4 per cent., and the parabolic mirror came out with an efficiency of 85·3 per cent. This experiment entirely does away with the idea that the Mangin mirror suffers in efficiency from absorption in the extra thickness of glass at its edges.

"The weak point of my opponent's reasoning has always been to suppose that Mangin mirrors could not be made with short focal lengths, and that they could not be severely calculated. Whatever Colonel Mangin's ideas were in 1873, it is certain that his mirrors have been greatly improved since that date. With this optical combination all focal lengths can be obtained, and the conditions shown to be the best by theory can be realised. Mr. Nerz was not, I think, aware of this until a comparatively recent date, and he cannot now put forward the argument that the parabolic mirror is the only one capable of being constructed with a suitable and sufficiently short focal length. I may even say that the improvements which have been realised, and which render the present Mangin mirror the most perfect and appropriate optical apparatus for military purposes, have not yet reached their limit. As in astronomical and physical instruments, so it is with the Mangin mirror, that the combinations of spherical surfaces with glasses of suitable indices of refraction always give results which are superior to those obtained where attempts are made to produce surfaces of non-uniform curvature.

"Mr. Nerz is in error in stating that I am an enemy of the horizontal lamp. I have always maintained that the employment of such a lamp with long focus mirrors is to be rejected, but with reduced focal lengths the inclined lamp is inferior to the horizontal lamp. Of this I have been well aware since 1888, and there is nothing astonishing in the employment of the horizontal lamp with Schuckert projectors, as they are all of short focus.

"In conclusion, I may state that I am not yet prepared to be converted to the parabolic mirror, and that experience proves to me more and more the accuracy of foresight of the French officers and engineers who created the art of the projection of light."

THE THOMSON MULTIPLE-CIRCUIT ARC LIGHT DYNAMO.*

Prof. Elihu Thomson has recently devised an interesting form of multipolar dynamo directly connected for a series of arc light circuits, and in which the commutation and regulation of each of the separate circuits is as simple as in the ordinary types of arc lighting machines. A series of arc lights may be run with continuous current on each circuit if desired.

The machine is shown in plan and sectional elevation in the accompanying illustration. It consists of a revolving set of multipolar field magnets on a water-wheel or steam-engine shaft, the number of poles being chosen with respect to the speed and rate of cutting of the lines desired. The armature is stationary, and is provided with circuits non-overlapping, constituting groups of three coils or three-phase windings, from which three terminals are carried out. This winding is supported on a laminated structure, divided into sections, so that any section may be removed with its winding for repairs without disturbing the integrity of the rest of the structure, which may even be run with one or more sections removed.

In order to commute the currents, commutators are driven synchronously with the machine or at higher rates by direct gearing as shown. The machine shaft carries a large gear, which engages with small pinions on each of the

* From the *Electrical Engineer* (New York).

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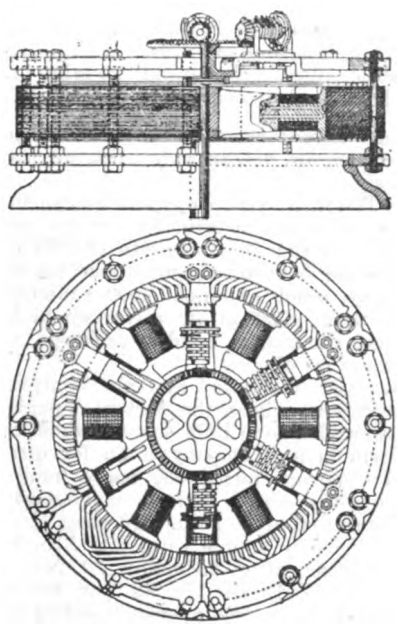
commutator shafts, the commutators being revolved at a speed relatively greater than that of the main machine in the proportion of half the number of poles in the main machine—that is, the commutator is virtually bipolar, or if the commutator has four poles its speed would be one-half as great. If the field poles of the main machine are 12 in number, as shown in the figure, the commutator would revolve six times as fast (if bipolar) as the machine. Each of the commutators carries three rings for connection by brushes to the stationary armature windings, and carries, also, a three-segment commutator with the ordinary arrangements of brushes, either controlled or not by a regulator.



The currents of the machine may be made by the armature reaction, resistances, etc., to be of the nature of those supplied by arc lighting machines, tending to a fall of potential on an increase of current, and thereby giving stability to the current on the circuit, or particular devices—such as reactive coils, constant-current transformers, etc.—may be inserted between the connections from the stationary windings and the commutating devices, and a transformation of potential up or down may be at the same time accomplished if transformers are employed. While the machine is thus primarily adapted to work a number of circuits of arc lights, it may be on occasion employed to operate three-phase motors or three-phase lighting circuits, or may be used in various transformer combinations to operate two-phase or other polyphase systems.

MUNICIPAL TELEPHONY.*

BY A. R. BENNETT.

(Continued from page 561.)

In estimating the cost of working the Trondhjem exchange it is necessary to explain that the Town Council has no wayleave charges to bear. It uses the townsmen's roofs by agreement, but in every case at present the proprietor is content with his roof being kept in repair, and exacts no annual payment. Of course, it is a serious matter to keep so many roofs in good order, but certainly the Trondhjem Town Council is exceptionally fortunate in escaping money payments in addition. In another respect the Trondhjem Municipality is more fortunate than telephone undertakers in this country—the 10 per cent. royalty payable to Government on exchange telephone subscriptions has no existence in Norway. Not that 10 per cent. added to the Trondhjem tariff would make much difference. The average payment would then be £2. 19s. 9d., instead of £2. 14s. 4d. Even a 10 per cent. royalty only assumes alarming dimensions when the subscriptions on which it is levied are high.

The switching arrangements at Trondhjem at present consist of eight 100-line boards by Ericsson and Co., Stockholm. There are no special features about them. The ring-off drops are connected in the cords in the usual way. This arrangement is somewhat antiquated, and will next year be superseded by a multiple board. A cross-connecting and lightning-guard board is also provided, the lightning-guards being of carbon blocks lying on a carbon plate in connection with the earth, and kept from contact with it by strips of mica. All the work in the exchange has been carried out with excessive neatness, and there is no suggestion of cheapness or neglect about the place.

The second instance of municipal control of telephone systems in Norway is that of Christiania. In my work on "The Telephone Systems of the Continent of Europe" I give full particulars of the Christiania Telephone Company, which has been a most successful concern. On an inclusive subscription of £4. 8s. 11d., it has for many years past paid a dividend of 5½ per cent. per annum on the capital invested after putting aside large reserve funds, writing off values of buildings and system, and providing benevolent funds for its male and female employés. The accounts given in my book for the years 1893 and 1894 bring out these details very clearly. At the end of 1894 the company possessed 4,627 exchange lines in Christiania and its immediate suburbs, in addition to being owner of a large system of trunk lines connecting Christiania with the neighbouring towns in every direction. At the end of September, 1895, the number of exchange lines had increased to over 5,000. The management of the company is invested in four directors, who meet every week, and a managing council consisting of 14 shareholders, which meets every month. This council is elected by the general body of shareholders, and in its turn elects the four directors. The Town Council, which owns a proportion of the shares, is represented directly on the board of the company by three town councillors, one of whom is a director, and the other two members of the managing council. The Municipality consequently exerts a great influence on the company's policy, which is to provide the best possible communication at the lowest rates commensurate with the payment of a fair dividend to the shareholders. The Town Council's share of the capital is contributed out of the rates, but as a return of 5½ per cent. is obtained on it, the ratepayers have no cause for discontent. The outside construction and the particulars of the subscribers' instruments have been fully described in my book, but the original multiple switchboard has just been replaced by one of largely increased capacity and of the most modern type, which switchboard was brought into use only last month. Although the number of subscribers in Christiania is so great, the rate at which new ones join continues undiminished, and it has therefore been necessary to provide for a very large additional number.

About two years ago a party in the Norwegian Parliament suggested that the State should take over the whole of the telephone companies, and a committee, consisting of the director of the State Telegraph Department and several other telegraph officials, together with two telephone managers, was appointed to examine the proposal. The committee, which was, of course, an ex-parliamentary one, reported in January, 1894, by a majority in favour of the State acquiring all the telephone exchanges, as well as the existing trunk lines; but there was also a minority report, which recommended that the State should only acquire the long trunk lines, leaving the local exchanges and the shorter trunk lines—that is to say, those connecting neighbouring towns—in the hands of the private companies and municipalities already working them. When the report of the committee was published, the Norwegian telephone companies and municipalities owning telephone systems formed themselves into a Defence Association, and after holding two meetings in Christiania, at which most of the companies and municipalities were represented, an energetic protest against the report of the committee was presented to Parliament. The contention of the Defence Association was that the State was not in a position to meet local requirements so well as local companies or municipalities could do, and so there would be danger of the great telephone progress which has hitherto distinguished Norway being arrested by the formulation of rules not adapted for the wants of particular localities. The Defence Association also considered it probable that the State would not be able to manage so economically as the various companies do, and that an increase on the very moderate existing rates would be found indispensable. The justice of this view was borne out by a proposal which had been made by the friends of State acquisition as soon as the report of the committee had become known, that the telephone subscription in Christiania, which for many years past has been £4. 8s. 11d. and has proved sufficient, as I have already stated, to return 5½ per cent. dividends regularly, should be increased to £5. 11s. 1d. The Defence Association adopted the minority report, and recommended that the local exchanges and the short trunk lines should be left in the hands of their present owners, while the State should acquire the longer trunk lines, which more nearly approximate to the character of telegraph lines. For two sessions no action was taken on the report of the committee, the number of the advocates of State acquisition being estimated at only about 20 per cent. of the members of Parliament, but just before the conclusion of the last session, in July, 1895, the permanent

* Paper read before the Northern Society of Electrical Engineers, November 11, 1895.

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Parliamentary Committee which controls the posts, telegraphs, and railways (which permanent committee consists of 15 members of Parliament) recommended that the Government should adopt the minority report of the original committee, and thereupon the Ministry decided that the Government should acquire the longer trunk lines only, leaving the local exchanges and shorter trunk lines, as they are at present, in the hands of municipalities and private companies. Private or municipal enterprise has, therefore, been definitely left in Norway to deal with the telephonic question, and from the energy and technical skill which the Norwegian telephone engineers have exhibited in the past there can be no doubt of the result; and it may be assumed that Norway will continue to develop her telephonic system to an extent of which most people in this country have no sort of conception.

There can be little doubt that State telegraph departments are not the best managers of telephonic facilities. In my paper read before the British Association at their recent Ipswich meeting, I gave many statistics and particulars on the progress of telephony in the chief European countries, from which it appeared that the greatest development and the lowest rates, together with the most liberal concessions to the public, are coincident not with Government control but with private enterprise. This view of the case has, since the meeting at Ipswich, been confirmed independently in a very singular manner. You have before you two maps—one of Jutland in the kingdom of Denmark, and the other of the province of Schleswig-Holstein in the empire of Germany, immediately to the south of Jutland. You will perceive that Jutland is covered by telephone exchanges, there being scarcely a village not possessing one, while trunk lines, shown in red on the map, connect all these together, and cover the country with a very network of wires. If you look now at the map of Schleswig-Holstein you will see that there are scarcely more than half-a-dozen telephone exchanges, while the trunk consist of one route running north and south from Flensburg through Kiel to Altona, with a branch to Rendsburg. The Chamber of Commerce of Flensburg, one of the chief towns of Schleswig-Holstein, has recently forwarded copies of these maps to the Imperial Government in Berlin, pointing out to the Government what I am now pointing out to you, that in Jutland, where telephonic enterprise is entirely in the hands of private companies, the country is covered with telephonic exchanges and telephonic trunk lines; that subscribers there are never charged more than £4. 3s. 4d. per annum, while in the majority of cases the charges do not exceed from £2. 10s. to £3. 10s. per annum. But in Schleswig-Holstein, south of the Danish frontier, the telephone system is in the hands of the Imperial German Post Office, with the result that, although the country is much richer and better populated than Jutland, telephone exchanges are few in number, possess few subscribers, and are infinitely worse off than the Danish in respect to trunk line communication, while the annual charges are never less then £7. 10s. per annum. The Flensburg Chamber of Commerce present these facts to the Imperial Government, and petition that measures may be taken to improve the development of telephones in Schleswig-Holstein, and especially that the present excessive charges should be reduced, pointing out that the social and physical conditions of Schleswig-Holstein are practically the same as those of Jutland, and if the rates of between £2. 10s. and £3. 10s. are remunerative in Jutland, they should be made equally so in Schleswig-Holstein. With the petition was forwarded a list of some of the Danish companies, giving particulars of their capital, number of subscribers, and dividends, from which it appears that the last range from 5 per cent. to 16 per cent. A more apposite and striking example of the differences between the management of Government departments and the results which follow the application of local intelligence, skill, and the employment of local capital, it would scarcely be possible to find, for only a few years ago Schleswig-Holstein belonged to the kingdom of Denmark, and was practically, what it still is geographically, a part of the peninsula of Jutland. Had it remained Danish, Schleswig-Holstein would doubtless be to-day as well telephoned as Jutland is, for private enterprise would not then have been throttled by Government monopoly. The German Telegraph Department is a highly organised concern, but it suffers from over-centralisation. The headquarters are in Berlin, and nothing can be done, however trivial, in any town or village in Schleswig-Holstein, or any other part of the vast territory controlled by the department, without previous consultation with and permission obtained from Berlin. Local conditions are ignored, and the smaller towns and villages can only obtain telephonic facilities by guaranteeing the Post Office, over whose management they have no control, against loss.

It must not be supposed that low rates are peculiar to Norway. Of the 31 exchanges in Holland all but three enjoy rates ranging from £4. 19s. 1½d. per annum down to £2. 9s. 7d. per annum, and these rates have proved remunerative to the undertakers. Sweden, Denmark, Switzerland, Luxemberg, and Finland afford additional examples of cheap telephony. But what experience have we in this country calculated to show that these low rates are as practicable here as on the Continent? A good deal if we examine the history of the last 15 years.

The rate of the Dundee and District Telephone Company was £5. 10s. per annum for any distance, and it paid an average dividend of 9 per cent. during the four and a quarter years of its existence. To buy it out the National had to return its capital with 40 per cent. added, besides paying bonuses to the chief officials. The cost of the lines erected by the company was £15 each. The Sheffield Telephone Company paid good dividends for many years on a £7 rate. The Sheffield people still enjoy better terms than the other large towns, since when the National Company acquired their system they were enabled, by threatening to call in an opposition company, to stipulate for a special tariff, which is still in force. The tariff is as follows:

	Per annum.
For distances not exceeding 1½ miles.....	£8 0 0
For distance not exceeding two miles.....	10 0 0
For each additional half mile beyond two miles	2 10 0
For private houses not exceeding two miles.....	7 0 0

These are much lower terms than those current in Manchester, Liverpool, or Glasgow, yet, as they exist, we may be sure that they are remunerative.

The Globe Telephone Company, which commenced an opposition exchange in London at £10, was bought over at an early stage in order that the monopoly rate of £20 might be maintained; the same fate subsequently overtook the New Telephone Company, which obtained 3,600 subscribers in London at a £12. 12s. rate. Such an enterprise would have been fatal to the National Company's London exchange, and had to be bought up regardless of cost.

But the best and most recent example occurred in your own city of Manchester, where the Mutual Telephone Company constructed an exchange in 1891 at rates which varied from £5 for shareholders in the company to £6 for non-shareholders. The Mutual Company introduced many improvements, and gave a service which was, I believe, unanimously regarded as much superior to that of its rival. The cost of connecting the Mutual subscribers by double wires was £16. 16s. each; the average subscription, after deducting 10 per cent. for Post Office royalty, was only £4. 12s. 2d. per line, a figure which approximates closely to the average receipts in Christiania; and yet after putting aside 5 per cent. on the capital expended for deterioration, paying directors' fees, and all working expenses, sufficient surplus was left to pay a dividend, had it been so desired, of 2·29 per cent. per annum. This was in the third half-year of the exchange's existence; subsequently the revenue increased rapidly, and with it the profit. At one time the Mutual Company had 1,389 lines working, but such a formidable rival could not be tolerated. The National Company got possession, and the exchange will shortly be a thing of the past, although about 1,000 lines are still connected to it. Soon those subscribers who for the last five years have been paying from £4 to £6 for a good service will be called upon to pay £10 per annum, or go without telephonic communication.

There is only one other aspect of the situation to which I shall call attention before concluding. It is the woeful effect which the existing monopoly is having upon our electrical industry. Abroad, immense quantities of telephonic apparatus are required to meet the rush of subscribers, and everywhere in France, Germany, Belgium, Switzerland, Sweden, Norway, we find extensive factories already in existence which are devoted entirely to the production of telephonic switchboards and apparatus, and more are continually coming into being. At Christiania I was shown a large building, still incomplete, which is being erected to meet the rapid extension of the Norske Electrisk Bureau's telephonic business. We have nothing of the kind in this country. Why? Because all important orders for instruments and switching apparatus are, and always have been, placed abroad, principally in America, and as a consequence no development of a British telephonic instrument industry has been possible. It is true that the Mutual Telephone Company used practically nothing but British-made apparatus, not because it was British only, but because it was of better design and better construction; but that was only a small indication of what would occur if telephones were free. Let those who have had experience of the rival systems in Manchester say which has given the most satisfaction—that of the National Company, whose apparatus is exclusively American, or that of the Mutual Company, whose apparatus was nearly exclusively British. The suppression of the existing monopoly in telephone exchanges would not only give the subscribers reduced rates and better service, but would practically create a new home manufacturing industry, for the prejudices which at present divert the orders for apparatus into foreign channels would not, it is to be hoped, hold sway with municipalities or with many competing companies.

Furthermore, the freeing of the telephone industry would provide an outlet for much of the surplus capital of the nation, which is now locked up for want of legitimate fields for employment, or, what is worse, is lent to unstable foreign states, or

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devoted to the development of foreign countries. Much has been heard lately of the absolute necessity of opening up new markets in Africa and elsewhere, but we have at hand a means of employing at least some of our surplus capital at a profit; of finding work for thousands of electricians, of artisans, of clerks, and of labourers; of, in fact, as I have already stated, creating a new and extensive home industry. That means is the reversal of the existing policy of telephonic monopoly.

THE ARC LIGHT.*

BY PROF. SILVANUS P. THOMPSON, D.SC., F.R.S.

LECTURE I.

(Continued from page 533.)

Physical Nature of the Arc.

I ventured, in a lecture I gave here in the year 1889 on the mechanism of the arc lamp, to make some remarks about this phenomenon. I began, however, from the optical point of view, from the researches of Captain Abney, which will engage our attention next week. Captain Abney had found the white surface of the luminous crater to be always of an equal degree of whiteness, which obviously means that it is always of an equal degree of temperature. No matter whether the current going through the arc is small or large, using big carbons or little ones, or whether the arc is long or short, the whiteness of the crater surface is always alike, and therefore of the same temperature. With large currents the area of the crater surface is large; with small currents it is small. Its quantity, but not its quality, changes when the current is altered.

I suggested at that date that the true explanation of this constancy in the intrinsic luminosity of the crater surface was that its temperature was fixed by physical conditions. It appeared that, whether the current was large or small, the temperature at that surface could not rise and could not fall; that it was, in fact, as fixed as the temperature at which ice melts or water freezes. The only thing that could account for there being a fixed temperature for the crater surface was the fact that the carbon is at that surface in a state of volatilisation; that the carbon is evaporating off from the positive carbon into the arc or flame†. At that surface you necessarily must have the temperature at which carbon evaporates, just as you cannot have the surface of ice under ordinary conditions either hotter or colder than the temperature which is taken as zero of the centigrade scale. If you take a piece of ice and put it in front of the fire, the ice itself does not get any warmer; it simply melts off at the surface, the surface of the solid remaining equally cold as before. So the surface of a piece of a carbon, when in contact with its own vapour, must necessarily be at that fixed temperature. That seems to be now the generally accepted idea.‡ I want now, however, to go a little further, and to suggest another idea to you.

It was found by Deprez, about 1850, that carbon just before it volatilises, becomes very soft—in fact, he obtained good evidence of plasticity in carbons when heated up to very near the temperature of the arc. Now, that means, of course, that there is, any rate, an incipient liquefaction going on a few degrees below the temperature of the volatilisation. Now, the temperature of liquefaction will also be a fixed temperature. If you have a film of literally liquid carbon lying on the top of solid carbon there must be a fixed temperature where they come together at the surface where the carbon is melting. There is some evidence that such films exist over the crater surface; but the temperature of the visible surface of the crater is the temperature at which solid carbon volatilises. My present view of the physical state of the arc crater is that the solid carbon below is covered with a layer or film of liquid carbon, just boiling or evaporating off.

The Hissing Arc.

When hissing takes places, a new state of things is set up. If you watch a short hissing arc you will see a column of light concentrating itself on a narrow spot, and that spot keeps moving about, and is very unstable in position as well as in the amount of light it gives out. The contracted spot from which the light seems to start pits deeper into the carbon. I think the first mention of this pitting effect of the hissing arc is not recorded anywhere yet, unless it was mentioned by Prof. Ayrton in 1893 in the paper he read at Chicago, which has never been published. I myself derived the information from Mrs. Ayrton, who made the observation that the crater surface, after the arc has been hissing, is found to be literally honeycombed. When the arc is hissing you can see little bits erupted out, and the hissing seems to be comparable to the hissing which takes place in water just when it is beginning to boil. If you have some water being heated in such a way that there is not more than a certain quantity of heat given off from the surface, you have the water evaporating quietly, but you cannot get more than a certain quantity of heat given off per square inch of top surface of the water in that quiet way. If you force more than a certain quantity of heat to pass off per top square inch of the water, you find the water begins to break up internally, and you have bubbles formed below the surface, the surface breaks up, the bubbles are thrown out, and you have a noisy phenomenon. I think you will find there is exactly the same kind of difference between the silent arc and the hissing arc as between quiet evaporation and noisy boiling. There is a sort of decrepitation, as though solid particles were being torn asunder to make way for something coming out, when the arc is hissing.*

Location of the Back E.M.F.

Another point which remained doubtful for a long time, even after Edlund had made his observations, and these measurements had been made, was whether this fixed voltage that appears in the arc was really the back E.M.F., as Edlund supposed, or whether it was a "transitional" resistance—a sort of resistance located at the surface of transition which, instead of being a constant, as resistances usually are, varied inversely as the current. That was, indeed, Schwendler's view. Schwendler said here is a resistance which varies inversely as the current; when you double the current, the resistance goes down one-half, therefore you want exactly the same voltage as before to drive that double current through. After all, it may be only a *façon de parler* to call this by either name, but at any rate reasons can be adduced in favour even of so improbable a view. Suppose there is a surface between a solid on one side and a vapour on the other. Apart from any question of evaporation going, or matter being given off from the solid into vapour at that surface, there is at that surface a difficulty in the current getting out from the material in one state to the other; that resistance will be, other things being equal, inversely proportional to the surface. One square millimetre of surface will offer a certain amount of difficulty; with two square millimetres you will have two possible paths, and the difficulty of transition will be halved. If there is anything that goes by area, then, if the resistance is transitional, as it is supposed to be, it will vary inversely as that area. Is there anything that goes by the area? Yes, the size of the arc which determines the size of the crater—I mean the cross-section of the arc is found to be almost exactly proportional to the current. If by any possibility you alter your current and pass twice as much current as before, I do not say it will burn equally steadily, but you will find the crater's area will be almost double. This observation was made a long time ago by Mr. J. D. F. Andrews, and is recorded in the *Journal* of the Society of Telegraph Engineers. If, then, the current produces a crater proportional to itself, and the transitional resistance varies inversely with the crater surface, it will vary inversely with the current, and the effect will become the same as though there were a fixed E.M.F. But I do not think that is the true explanation, because I do not believe in this transitional resistance. It seems to be a way of explaining a thing by introducing something which is much less understandable. When you have come to this explanation, you have to explain the transitional resistance; but you can explain and see the reason for a counter E.M.F. Whenever work is done by a current in a circuit, it is always done by virtue of a back E.M.F. The fact that there is a back E.M.F. in a motor enables you to utilise the electrical energy. The fact that there is a counter E.M.F. in an accumulator that you are charging enables you to store chemical energy in it. The fact that there is a back E.M.F. in an arc enables you to do work in that arc. If there is a back E.M.F., it ought to have a definite seat. Has it a definite seat? Where are these 39 volts? Are they at the crater surface? Are they distributed all along the arc? Are they at the negative peak? That was one of the points which was entirely uncertain until a few years ago. Several of us have worked at it, Prof. Fleming and Prof. Ayrton amongst others. An observation which I made some years ago was communicated to the Electrical Engineers at the time. I made an arc in the usual vertical way, with the positive carbon at the top. In Fig. 4, in order to plot volts vertically against lengths horizontally, the arc is represented as turned over on its side, and the distance between positive and negative electrodes is greatly exaggerated. Into the space between the crater and the peak I then introduced a third carbon to act as an explorer. The difference of potential between the two points, as measured with a voltmeter, was about 45 volts; and to measure this the wires of the voltmeter must be connected, the one to the negative, the other to the positive carbon. But if one wire is connected to the negative

* Cantor lectures delivered before the Society of Arts.

† See an excellent lecture on the "Arc Light" by Prof. Elihu Thomson, in *Electrical World*, xvii., p. 166, Feb. 28, 1891.

‡ Some recent experiments by Mr. W. E. Wilson (see *Proceedings*, Royal Society, May, 1895) are supposed to throw some doubt upon my theory; they are referred to below.—S. P. T.

* For other observations on the "hissing" phenomenon see: Cross and Shepard, *Proceedings* American Academy, 1886, p. 227; Niaudet, *La Lumière Electrique*, iii., p. 287; Luggin, *Electrician*, xxvi., p. 565; Spencer, *Electrical Review*, xxiii., p. 496; Andrews, *Journal* Society Telegraph Engineers, ix., p. 201; Cravath, *Electrical World*, xix., p. 195.

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carbon, and the other to the third or exploring carbon, one is enabled to go fishing about to find how this 45 volts of potential difference is distributed along the arc. If the arc merely operated as a plain resistance, the fall of potential would be found to be distributed along the length equably; when the exploring carbon had been moved through half the length, the voltmeter would just show 22½ volts. But nothing of the sort is found. At a point half-way along, the potential was found to be about four volts higher than the negative carbon; and as the third carbon was moved towards the crater, this rose to nearly six volts. This process, then, enables one to locate the whereabouts of these 39 volts of back E.M.F. Suppose one plots out vertically the results of the observation, as in Fig. 4, the high-level line to represent the potential of the positive carbon, the low-level line the potential of the negative carbon, then the volts drop from high to low, somewhere or other in the distance from crater to peak. We might, of course, have measured the voltage drop from the positive carbon downwards, instead of measuring it from the negative carbon upwards. This method of exploration is precisely similar to that known and used for years in examining the polarisation of secondary batteries. Inspection of the diagram that has been plotted from the observations shows that there is a drop of something like 39 volts at the crater, and then there is a slight regular drop all the way down the arc, due to the fact that there is current going through resistance; then there is a slight drop at the other end of the peak. I measured that slight drop to be two or three volts; but in one case, where the arc was hissing, I found at that place a slight rise. Other observers* have also obtained a rise at this end, showing that some inverse phenomenon is going on there. The same kind of thing occurs frequently in electrolytic observations. One finds the potential of the intermediate liquid lower than that of either of the materials at the two ends.

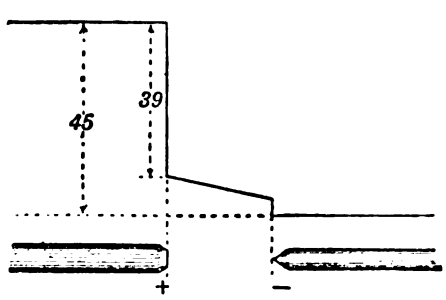

FIG. 4.

If there were a hissing arc instead of a silent one, the drop at the crater would be found to be only about 13 volts there, and the whole voltage from one side to the other would be very much less. Many years ago the observation was made by M. Niaudet that the current, if supplied under certain conditions, increases at the moment when the arc begins to hiss; if supplied under certain other conditions it, however, decreases at the moment when the arc begins to hiss. This apparent back E.M.F. has not only been a puzzle to the investigator, but it has led to several fallacious suggestions. There is a remarkable paper in the *Comptes Rendus* for 1884, by the late Prof. Jamin. Jamin was an intelligent man, but he formed this extraordinary opinion that an alternating-current arc would necessarily be much more efficient than any arc could possibly be when produced by a continuous current, whether from a battery, an accumulator, or anything else. For, said he, if you work with a battery or an accumulator, that current always flows in one direction, and you have 39 volts against you—that means a pure loss of energy, which is thrown away; whereas if you work with a rapidly alternating current, the back E.M.F. will help you at each reversal of the current. Therefore, the alternating current will be very much more efficient. Of course, the whole thing is a mare's nest. Jamin did not understand that the essence of getting work out of a current, whether from a motor or an arc, was to have back E.M.F.

Another matter which has never yet been properly cleared up is the transport of matter across from one side of the arc to the other. Unquestionably in a hissing arc there is a large transport, particles of carbon in solid or liquid state being visibly projected across the gap to form the mushroom on the negative peak. Besides this bodily transport, there is probably also a molecular transport by evaporation at one side, and condensation at the other. But the hissing arc is not the normal phenomenon, and the transport of actual particles is abnormal. In a silent arc there is very little. You may, in fact, substitute as a negative pole a piece of metal, if you keep it cool and prevent it from melting. The evaporation of carbon at the positive surface is quite sufficient to keep the arc going. However, some researches have been made on this point. Sir William Grove thought he got a transport in both directions, as did Matteucci, who employed, instead of carbon, a pole of iron and a pole of copper. On examining the two surfaces after an arc had been allowed to play across, he found that some carbon had been carried over to the iron, and some iron had been carried on to the surface of the copper. But the spluttering effects one gets when using metals in this way make one very unwilling to accept such results as conclusive. A recent experiment of M. Blondel in photographing the image of the arc proves, if anything can prove, that there is only one direction in which material is ever transported, and that is from the positive side to the negative, from the crater to the peak.

ALTERNATE-CURRENT ARCS.

I have the means here of showing an alternating-current arc. We will turn on the current from the London Electric Supply Company, and I will show the alternating arc first by means of one of those nearly obsolete devices, one which has now become almost a museum curiosity—a Jablochkoff candle. All honour to Paul Jablochkoff. In the year 1877, he revived this elementary method of providing for an arc; avoiding all mechanism, by simply putting the two carbon pencils parallel at a suitable distance apart, one by the side of the other, with a bit of plaster between. On switching the candle into circuit, the alternating current passes from one point to the other after being started by a temporary bridge-piece. Jablochkoff used the alternating current, simply because it was essential that the consumption should be equal at both tips. In the use of the alternate current the actions at the tips reverse at every reversal of the current. For an instant the current flows in one direction, then reverses, only to reverse back again. For a brief time the crater will be forming on one tip, and the negative peak on the other; then a very small fraction of a second afterwards the action is reversed, and so the two carbons are consumed away at equal rates. But, for my own part, I do not admire the light from the Jablochkoff candle. It always roars and hums because of the alternations that are going on. The light is down in a hole between two carbons, so that it is not diffused in the most satisfactory or economical or agreeable way.

HIGH-VOLTAGE ALTERNATING ARC.

While I have an alternating current here I should like to show you another arc phenomenon that is not often seen, at any rate, outside electric lighting stations. I refer to the alternating-current arc at 2,000 volts. The arc that one gets from a current when elevated to such a high E.M.F. as that will be very much more like that which Davy produced with his charcoal points and his battery of 2,000 cells. That is to say, it will be a real arch of flame between two points, and this arch will be blown upwards by the ascending current of air. You will notice that the whole arch itself is more or less luminous. You will see that we get great roaring flames, but you will be astonished to find how little carbon is consumed by this 2,000-volt arc. In fact, the higher one goes in voltage with the arc the less carbon is consumed, and in some cases the less light you get. But the consumed carbon is very small, and these flames appear to be rather of the nature of true flames. Only there is this difference: instead of taking combustible materials, putting them together and burning them in order to get out heat, you are taking materials which do not ordinarily burn together—viz., the two constituents of the air, nitrogen and oxygen—and you are forcing them to burn together by pumping heat into them. It is an endothermic flame, instead of the ordinary exothermic flame. It is a flame which takes in heat from the current, which requires to be fed with heat, in order to exist at all. Certainly some of the luminous phenomena one gets with high voltage and at high frequencies are of this nature, and therefore are not like the true arc. In the arc itself, when made in the air, undoubtedly there is a combustion of the air—that is to say, the oxygen and nitrogen of the surrounding air are burnt together by the heat, and also both of them combine with carbon.

CHEMISTRY OF THE ARC.

The chemistry of the arc has never been thoroughly worked out. Prof. Dewar, amongst others, has worked at it and shown that not only do you have carbonic acid and carbonic oxide produced, but nitrogen compounds, prussic acid, cyanogen, nitrous acid, and various others. He drew off the gases through tubular carbons and analysed them.

I do not think anyone has in any record called attention to the smell of the arc lamp. The arc certainly has a very characteristic odour, probably due to the fact that the carbon is combining both with nitrogen and with oxygen, and that the nitrogen and the oxygen are combining together, giving rise to compounds which, though more or less poisonous, are happily produced in very small quantities, and give a decided odour to the air where an arc is being made. These flaming arcs, at high voltages, very soon produce a perceptible odour: whereas a normal arc, produced actually by 40 to 50 volts, gives very little smell indeed, and sets free extremely little of the disagreeable nitrogenous products.

* Dr. Sahulka, *Zeitschrift für Elcktrotech.*, November, 1894; but see J. A. Fleming, "Electric Lamps and Electric Lighting."

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Magnetic Properties of the Arc.

Amongst the early things that Davy discovered was the effect of a magnet on the arc. He showed that the arc behaved like a flexible conductor, and a magnet being put near it caused it to bend to one side or the other. If the current in it is ascending, it is bent to one side in the magnetic field; and if it is descending, the arc is bent to the other side. In the case of the horizontal arc, it makes a difference whether the current is flowing eastwards or westwards: in the one case, the earth's magnetic field tends to bend it up, and in the other case it tends to bend it down. As a consequence, you can get a larger maximum length of arc with a given current, if the current comes in at the east and goes out at the west, than if it comes in at the west and goes out at the east. Also, with an alternating-current arc, where the current flows alternately up and down, the flame of the arc is literally pushed on one side. If you examine an alternating-current arc in a mirror that rotates round a horizontal axis so as to get a succession of images thrown out vertically, you will find that those images are successively curved right and left, owing to the effect of the earth's magnetism. Walker and De la Rive observed the arc to rotate round a magnetic pole, and a number of kindred experiments have been made which are very curious. I will only show you one. Here is an electromagnet which I can introduce into the circuit. I will take a pair of carbon pencils, and placing them between the poles of the magnet, I will try to obtain the arc, using 40 or 50 volts in the arc circuit. You know that ordinarily the arc goes out if the carbons are parted too far. When it does go out it does not make much noise; there is a slight sound like that heard when a candle is puffed out. But try it between the poles of that magnet, what do you find? You cannot even get the arc to keep alight. It flops out instantaneously with a sound almost like a pistol shot. The flame is blown inwards or outwards, according to whether the current is flowing down or coming up. You notice that I put one carbon at the top and the other at the bottom, and then the magnet blows the flame outwards. If I reverse the carbons and put the negative at the top, the flame will be blown inwards. Even if one works at some distance away from the poles of the magnet you still observe this very peculiar effect. To burn the arc steadily in a strong magnetic field is almost impossible. If I had a larger E.M.F., say, 300 or 400 volts, so that I could support a long flaming arch between those two carbons, and were to form such an arc, it would be blown out sideways, like a blowpipe flame. This was observed long ago by Quet in 1852, and in 1874 by the late Mr. Werdermann, who proposed to employ it as a sort of blowpipe. He set two carbons side by side like a Jablochkoff candle, and arranged a magnet to blow out the flame in a long tongue, for use in soldering or lead-burning, instead of a blowpipe. Recently others have combined magnets with arcs for the purpose of making electric blowpipes. The Benardos process of electric welding and forging is based on this particular use of the arc.

(To be continued.)

WORM-GEARING IN CONNECTION WITH ELECTRIC MOTORS.

In a paper read before the Electrotechnischer Verein of Vienna,* Mr. Ernst Egger described, with the aid of illustrations, various kinds of of electrically-operated elevators. The author stated that when worm-gearing was employed for transmitting the power direct from the motor shaft to the drum it was particularly advantageous to use low-speed motors. This expression of opinion has elicited a response from Mr. Emil Kolben, of the Oerlikon Works, who contradicts this assertion.

In correcting this erroneous idea which has generally been held, Mr. Kolben states that high-speed motors should be exclusively conducted in conjunction with worm-gearing, if the work is to be commercially practicable and a good efficiency realised. It is from this standpoint that the question is of importance to electrical engineers, since, although no particular difficulties are met with in the construction of motors to run at low speeds, yet the motors are heavy, bulky and expensive, so that the use of such motors in many cases is excluded. As, on the one hand, the employment of worm-gear is regarded with great mistrust, and yet, on the other, this kind of gear is the most important reducing mechanism for electrically-driven tools, cranes and lifts, and for vehicles, Mr. Kolben thinks it right that some facts should be adduced for the benefit of the electrical industry.

Proceeding to deal with this question, the author points out that a great predjudice against worm-gear has hitherto existed, on account of its having been regarded in the old text and hand books as an inefficient means of transmission; and not unjustly so when the method of constructing the gear is considered. After referring to the work in this direction by Profs. Thurstone and Kimbal and Mr. Towne in the United States, and by the late Mr. A Reckenzaun, who obtained an efficiency of 87 per cent., and subsequently by Mr. Sellers in Philadelphia, the author discussed the efficiency tests recently carried out by Prof. Stodola, of the Zürich Polytechnic, with the ordinary double-thread worm-gear of the Oerlikon Works.

The worm was 3⅛in. in diameter, had a multiple-ring bearing and engaged with a worm-wheel having 28 teeth, the wheel being of bronze, 14¾in. in diameter. The whole of this gear was placed in oil in a cast-iron box. The gear was coupled to a 20-h.p. electric motor, and the braking tests were made on the worm-wheel shaft. The results were as favourable as in the case previously mentioned. At 1,500 revolutions, a useful performance of 21 h.p. was given on the brake, the efficiency amounting to 87 per cent. The author, who had previously conducted a series of experiments which agreed with the result above cited, is of opinion that the efficiency with the motor fully loaded will increase even beyond 80 per cent., if the following points are considered in the construction and fitting up of the gear for direct coupling with electric motors.

(1) The starting speed should, according to the output, amount to from 20ft. to 40ft. per second, instead of from 7ft. to 16ft., as has hitherto been customary. This condition necessitates the use, not only of high motor speeds, but also of a large diameter of worm, and consequently great distances between the teeth, powerful teeth, and ample bearing surface. By this means the total friction will be reduced. For the purposes mentioned the motors required range from 2 h.p. to 25 h.p., with usual speeds varying between 1,600 to 800 revolutions a minute. As the elevator drums to be operated, the driving spindles of machine tools, and the car axles of tramcars have speeds of from 150 to 40 revolutions a minute, it is possible to obtain in the most simple manner, without any intermediate gear, the whole speed reduction by means of worm-gearing, with a single or double thread worm having a ratio of reduction of 10 to 1 or 20 to 1.

(2) The mechanical production of worm gear requires the greatest care, if it is to be useful for the direct coupling of motors. The worm must be turned out of a solid piece of tool steel, and be tempered, smoothed, and polished. The crown of the teeth should be made of hard phosphor bronze, and if of large diameter it should be drawn hot on to a cast-iron arm crown. The teeth are to be properly cut and polished. The whole gear is to be closed in a box and allowed to work in an oil-bath. This arrangement will reduce the friction coefficient between steel and bronze from 0·01 to 0·005. Gear constructed in this manner runs noiselessly, has only a slight wear, and a life of several years.

(3) In order to reduce to a minimum the friction of the whole mechanism on the starting of motors at full load, the pressure is taken up by starting discs arranged on both ends of the worm.

* *Elektrotechnische Zeitschrift*, July 18, 1895, p. 450; August 15, 1895, p. 514.

HEATON AND CO.'S ELECTRICAL FITTINGS.

Messrs. Heaton and Co., of Salford Switch Works, Salford, Manchester, have lately submitted to our representative samples of electrical fittings which embody several good points, both of construction and design. This is especially the case with their switches, three forms of which we illustrate.

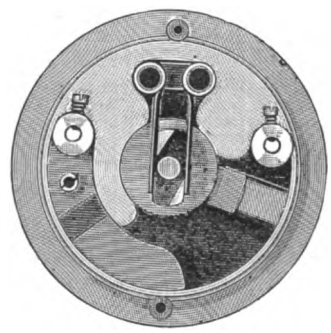

Fig. 1.

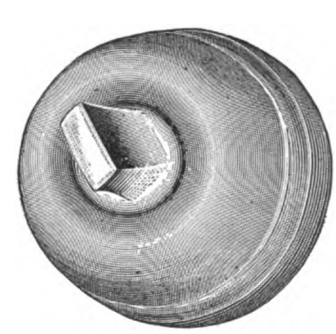

Fig. 2.

Figs. 1 and 2 give interior and exterior views of the "A" type "thumb" switches, which are stocked in three sizes for currents of respectively 5, 10, and 15 amperes. The base and cover are of either white or black porcelain. The chief point about this switch is the steel wire controlling spring, which bears on the lozenge-shaped boss on the spindle. The spring, wound in one piece and mounted on two studs, has two "prongs,"

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as shown (Fig. 1). The advantage of this is that the strain is distributed between them, and in the thus reduced likelihood of one "prong" breaking, the other still acts: and, owing to the special method of mounting, with renewed strength. The switch, therefore, as compared with most others, has two "lives," so to speak. The porcelain handle fits loosely on to the boss above-mentioned, so that the switch will spring off independently of the handle, and the latter is removable with the cover, enabling the parts to be easily inspected and cleaned. One terminal, the spring, and the movable tongue are all mounted on a common brass base, and when the switch is "on" the thickened end of the tongue wedges in the gap between the bottom brass base and the upper brass plate connected with the second terminal, so that good contact is secured. In the figure, owing to a draughtsman's error, the holding-down nut, screw-holes, etc., are shown too small. These switches can be supplied with removable key handles, and with fluted brass or decorated covers.

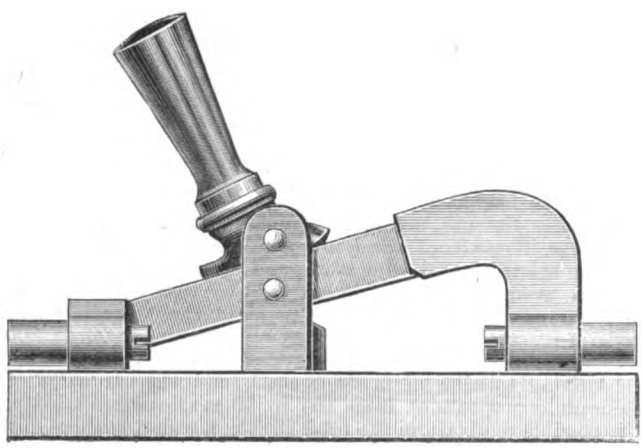

FIG. 3.

A neat form of double-pole double-break switch on square slate base, in square polished brass or teak case, with ebonite handle, is claimed to be the smallest D.P. switch on the market, it being stocked in sizes from 5 to 50 amperes. This is known as the "D" type switch, and is certainly very simple and substantial in construction. Two-way five-ampere switches of this design are useful for controlling the same lamp or lamps from two points; the method of wiring being such that the same lamps may be turned "on" or "off" at either switch, or "on" at one switch and "off" at the other.

Fig. 3 illustrates the "L" type double-break main switch for currents of from 25 to 400 amperes. The movable contact lever is pivoted on the centre upright, and is formed of two thick copper strips about ¼in. apart, fixed together by a short piece between them at the point where they are hinged. On the underside, just below the pivot, is a protruding portion on which the upper end of a strong coiled spring sunk in the base

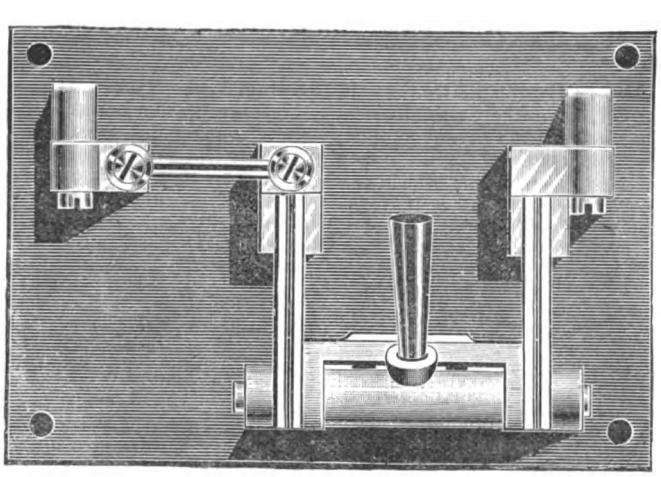

FIG. 4.

acts, forcing and keeping the lever in either the "on" or the "off" position. The switch handle is hinged independently of and just above the contact lever. In the figure the switch is shown "on," and to pull it "off" the handle would be moved to the right. The spring is only compressed during the act of putting the switch "on" or "off," so it is not likely to lose its elasticity. The ends of the lever, which are like those shown in Fig. 4, wedge into similar contact blocks, to which are screwed the sweating sockets. The switch is quick-break, and the parts are mounted on enamelled slate bases, with or without fuse terminals as desired. Switches of this kind can be coupled up in tandem or abreast for double or triple pole work.

Fig. 4 shows a double-break single-pole fuse switch of workmanlike design, and known as the "M" type. It is made for currents from 25 to 200 amperes. The pull-off spring is coiled round the axle and encased in a tube carrying the handle. The copper contact tongues are fixed at opposite ends of a frame, and it will be seen that there is a solid metallic circuit from one contact block to the other. The same type of switch without fuse is stocked, and the sweating terminals are arranged to couple up either above the base, as shown, or below. The parts are either polished and lacquered, or part steel-bronzed and part polished, the bases being of enamelled or paraffin-waxed slate.

Two switches of this type mounted abreast and connected by a stout vulcanite handle bar form a very efficient double-pole switch. These (called the "M D P" type) are made for the same currents as the "M" type. They are supplied, when required, with covers and protruding handles.

The "N" type quick-break two-way switch is useful for coupling either of two dynamos to one circuit, or either of two circuits to one dynamo, and is so constructed as to remain in the central or "off" position when the circuit is broken.

This firm make a form of ceiling-rose with a new and efficient cord-grip. Forming part of each terminal plate are brass holders, bent at right angles. The cord is laid in these, and the latter are pinched in with a pair of pliers so as to effectually grip the cord. The terminal plates are securely screwed to the porcelain base, and all strain is taken off the terminal screws. When it is desired to release the cord, the "grips," or holders, can easily be opened by means of the edge of a screwdriver, etc. Instead of pinching the "grips" on to the cord, a double turn of the latter round them will take all the weight off the terminal screws. The great advantage claimed for this ceiling-rose is that it is quickly wired.

Cord-grips, as above described, are also fitted in a neat form of "triple-suspension ball" for suspending three lamps from one ceiling-rose.

Besides the switches, etc., already mentioned, Messrs. Heaton and Co. make various kinds of cut-outs, and fuse and switchboards, as well as lamp fittings.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE CONTROL OF ELECTRIC CARS.

SIR,—An incident which happened lately at Havre will be of interest to your readers, as showing how easily an electric tramcar may be controlled and operated. One of the cars was running at normal speed along the street when a child, four years old, suddenly ran right in front of it when only a yard away. The "wattman" (as the motorman is called in France) could not, of course, avoid passing over the child, whose body somehow dodged the fender, but he pulled up the car in *half its length;* and the poor child was safely taken out from under the car through the movable floor panels, with a rather serious wound on the head and suffering from shock, as might be supposed, but alive and likely soon to recover.

It is not very pleasant to think of what might have happened with a steam, cable, or even an ordinary horse car in such a case. There seems little doubt that the child would have been killed at once.—Yours, etc.,

Rouen, November 14, 1895. FRANK B. LEA.

DRIVING SHIPS BY ELECTRICITY.

SIR,—I felt rather surprised that a somewhat unfavourable comment should have been made respecting the note on p. 551 of your last issue—"A Marine Electric Locomotive." The idea struck me as being a very good one, if only to get rid of the everlasting throb of the screw-shaft. So far as engine economy itself is concerned, probably the slow-speed compound condensing Corliss engine proposed for use would not be materially cheaper to work than the present types of marine engines, which often burn less than 2lb. of coal per indicated horse-power, though not on a transatlantic liner. But although the double transformation effects a loss of perhaps 5 to 8 per cent., it must be remembered that the long lengths of screwshaft with bearings, etc., is practically done

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away with, and even the thrust bearing might be abolished by training the end pressure of the screw more directly against the keel or bottom framework. For such passages as across the Channel or Atlantic, the matter of doing away with vibration is alone well worth a 10 per cent. loss in transmitting the power from engine to screw. I don't envy anyone the task of designing suitable motors, though, for such work as would be acquired.—Yours, etc.,

BAD SAILOR.

HIGH-VOLTAGE LAMPS.

SIR,—In your issue dated November 8, I find there is a notice on the high-voltage lamp manufactured by Messrs G. Straus and Co. The letter therein referred to was forwarded on behalf of the first consignment of lamps received, and not for the pattern illustrated in your notice. This letter has now been incorporated in their catalogue (together with a clerical or printer's error) without my knowledge or consent.

Had they adhered to their original design and quality of lamp, I should not have considered it necessary to call attention to this matter.—Yours, etc.,

SYDNEY W. BAYNES.

REVIEWS.

Recettes de l'Electricien. Collected and arranged by Prof. E. HOSPITALIER, editor of *L'Industrie Electrique*. Illustrated. Price 4f.

General books of recipes are common as blackberries in autumn. Such books are also well known relating only to engineering matters; but as each department of engineering becomes more and more a speciality, a need will probably be found for books of recipes for each special department. M. Hospitalier has given us one for the electrician. Even this traverses a pretty wide field, giving as it does recipes relating to fusible alloys, solders, cements, plating, coil-winding, tools, bands, lubrication, making mirrors, delicate suspensions, batteries, electrolytic work, distribution, jointing, insulators, switches, cut-outs, accumulators, and various other matters connected with electrical work. He also gives what may be called a *résumé* of electric law in France. The selection and arrangement of some hundreds of recipes is a task which can be done in two ways. It may be a mere collection by the aid of paste and scissors—the selection haphazard—or the selection may be carefully done by a man desirous of minimising the labours of those engaged in the industry, who selects with a knowledge of what is good and what is bad. M. Hospitalier is of the latter class; his life has been devoted to the study of electrical matters, and therefore his selection is of the best.

THE ROTTINGDEAN ELECTRIC RAILWAY.

THE APPLICATION GRANTED.

A special meeting of the Brighton Town Council was held at the Town Hall on Saturday last for the purpose of resuming the consideration of the report of the Works Committee with reference to the application of the Brighton and Rottingdean Seashore Electric Tramroad Company for permission to erect poles on the seashore for the purpose of the working of their tramroad.

The **Town Clerk** mentioned that the Borough Surveyor and Mr. Arthur Wright (electrical engineer) were in attendance on behalf of the Corporation, and Mr. Magnus Volk and Mr. St. George Moore on behalf of the company, and these gentlemen were invited to enter the Council-chamber.

Mr. St. George Moore, civil engineer to the company, first addressed the committee. He said he would like first—being responsible to the directors for the due observance of the technical questions in the Act of Parliament—to explain by means of diagrams how he had endeavoured to comply with the provision in the Act that the line should not be more than 4in. above the chalk or sand. As the sand was constantly varying in level, he estimated the true meaning of the words, "not more than 4in. above the sand," to be not more than 4in. above the maximum level of the sand, as otherwise the plant would be worthless and the railway unworkable. Mr. Moore exhibited diagrams showing sections of the sand at four spots east of the Paston-place groyne, a line being taken north and south, and pointed out that in the first case if the sand were levelled the northern rail in the first section would be 3in. above the sand, in the second 3in. below the sand, and in the third 11in. below the sand. There were in the Act of Parliament practically three instructions as to the course to be pursued. The plans were to be approved by the surveyor, there was power of deviation from the plans within certain limits, and the line was to be not more than 4in. above the chalk, rock, and sand. In ordinary railway practice they had been in the habit of using this power of variation, and all he had to say was that, in adopting this custom without submitting fresh plans to the borough surveyor to cover the little variations he found necessary to keep the line 4in. above the level of the shifting sand, he had done it inadvertently, and without any wish to do anything that would offend the Corporation.

With regard to the weight of the car, the engineer who first advised the company said he thought a car weighing about 20 tons would suffice, but he (Mr. Moore) must confess that when he calculated the strength of each individual part of the car, and went into the affair thoroughly, he found that the weight must be increased. The gross weight of the car without the electrical machinery—for nobody knew yet what kind of machinery would be used—was calculated as 35 tons 13cwt. 1qr. 12lb., but there were sundries which might raise the weight to 40 tons, and 150 passengers would weigh about 7 tons 10cwt. The weight of machinery would be 7 or 8 tons if accumulators were used; 7½ or 8½ tons for steam, and about 2 tons for the trolley system. The horse-power required would vary greatly. At low tide, with an incline of 1 in 300 on a 40-chain curve against a 14-mile wind, 24 h.p. would be necessary for a speed of six miles an hour; running with bogies in the water, 40 h.p. would be needed under similar conditions, and with the car submerged, 63 h.p. Dealing with the four motive powers suggested, he said he understood the Corporation objected to the use of steam, while with gas or oil engines at such height above the rails the vibration would be excessive, and in the two latter cases the smell and noise would be objectionable, and there were serious, if not insuperable, mechanical difficulties in reversing and starting the engines. He was not an electrical engineer, and could not go into the arguments for or against the accumulator or the trolley system, but he ventured to point out this and steam were the only two systems which had been tried and proved successful.

Questions were then addressed to Mr. Moore by several members and by the officers of the Corporation. In reply to **Alderman Moon**, who asked whether or not the original weight of the car was 20 tons, **Mr. Moore** replied that the car spoken of as the original one was never designed; it was only a sketch.

The **Borough Engineer** (Mr. May) asked Mr. Moore if it was not a fact that there was no sand now at the spots represented in the diagrams produced. **Mr. Moore** replied that the diagrams represented the highest sand level while the works were in progress. **Mr. May** asked if the parliamentary plans did not show the chalk cut and indented to carry the sleepers, so that the rails were level with the top of the chalk. **Mr. Moore** replied that this was so, but that one section could not be supposed to control rails three miles long. **Mr. May** asked if it was not usual to give plans of any variations rendered necessary. If one section only were submitted would it not be assumed that that applied to the whole of the scheme? **Mr. Moore** said the ordinary practice of fixing a line was a well known quantity. This was a different matter altogether, and all they could show first in plans was the general principle. **Mr. May** asked if the line had been constructed in the manner shown? **Mr. Moore**: In a large number of places, yes.

Alderman Moon asked Mr. Volk who was responsible for advising the erection of the poles 80 yards apart. **Mr. Volk** replied that he was responsible for the position of the poles, but as he had not had experience in putting up poles he referred the matter to Mr. Dawson, the company's consulting electrical engineer. Mr. Dawson had put up many miles of trolley line, and he assured him that the wire could be safely worked with the poles 80 yards apart. **Alderman Moon** next questioned Mr. Dawson as to the possibility of adopting the Westinghouse system, which is in use at Washington, and in which the wires are underground. **Mr. Dawson** held that it would be impossible to adapt it to a case where the cars were running over water.

Mr. Wright, replying to a question addressed to him by Councillor Stafford, said he thought the use of a gas motor would be the cheapest solution of the present difficulty. It could be worked much more cheaply than an electric motor, and, according to Prof. Kennedy, the vibration produced would not be noticeable. Nor did he consider there was any danger from explosion; while in connection with the gas-motor in use elsewhere on tramcars, there was an arrangement for starting, reversing, slowing, and for increasing speed in going up hill, and he saw no difficulty in applying that system on the largest scale necessary for the purposes of this railway.

After further discussion, the **Town Clerk** reported the resolution as a recommendation from the committee of the Council as follows: "That the application of the Brighton and Rottingdean Seashore Electric Tramway Company, dated September 23, 1895, for permission to erect 13 tubular steel poles 80 yards apart on the foreshore between Paston-place jetty and the borough boundary at Black Rock, for the purpose of carrying the electric trolley line be, and is hereby, granted, provided that the company pay a rental of £1 per annum and enter into a bond for £1,000, with two approved sureties, to remove the poles within three months after the receipt of a notice to that effect from the Corporation, and also to remove the rails and concrete blocks in the event of the line being abandoned, or not worked for a period of six months."

This resolution was carried unanimously.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE PACIFIC CABLE.

The beginning of the end in regard to this proposed cable seems to have arrived. A private deputation of Colonial representatives conferred with Mr. Chamberlain on this subject at the Colonial Office on Tuesday, and Mr. Chamberlain's views have been made public. He is reported to have observed that such a meeting of the council of the Empire, brought together for the purposes of common interest, and attended by representatives of the Cape and Natal, which were not concerned with the project in its present form, was an evidence of solidity and sympathy. He expressed his opinion that the project showed a very fair prospect of remunerative return on the capital required, and his willingness to join in the formation of a joint commission, which should report upon the subject. He suggested that a commission should be formed, consisting of two representatives of Great Britain, two of Australasia, and two of Canada. After some discussion, it was arranged that the Colonial representatives should be named by the Colonial Governments and appointed by the Imperial Government, and that the commission should consider and report upon the subject in all its aspects. It was also arranged that the Agents-General and the High Commissioner of Canada would move their Governments to appoint representatives on this understanding.

The *Chronicle*, in a leader on Wednesday, commenting on this interview, among other things, says: "The scheme has been in the air for more than ten years. It took definite shape at the Ottawa Conference last year, and the fact that it yesterday received the approval of so many of the Australasian Governments is proof of the need at the Antipodes of this second telegraphic line to England. Even the Cape and Natal sent their Agents-General to yesterday's conference, for they look forward to the day when branch lines from the main cable may open up new telegraphic routes for them. It was, then, in the words of Mr. Chamberlain, a meeting of the council of the Empire for purposes of common interest, and the Colonial Secretary made it at once clear that the scheme would have the full co-operation of the Imperial Government in view of the great commercial and strategic advantages arising from an alternative and all-British cable line to the Antipodes. Primarily, of course, the cable is a question of cost. It was estimated at the Ottawa Conference that it would take two millions sterling to lay a single cable from Vancouver to Australia, and the figures put before the conference suggested that under a joint Government guarantee of interest the undertaking would in a few years become self-supporting."

Referring to the work of the commission, the *Chronicle* continues: "Two alternatives will be brought before that commission. The construction and working of the cable may be handed over to a company under some form of Government guarantee, or it may be undertaken by the Imperial and Colonial Governments and worked as a joint State undertaking, as our inland telegraphs are. The weight of Colonial opinion favours a State system, but the position of the existing lines under Sir John Pender's control would then have to be considered. All this,

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however, the commission will weigh. The material fact for the moment is that Mr. Chamberlain has pledged the Imperial Government to co-operate with the Colonial Governments in the undertaking."

Our opinion has long since been freely expressed, and is in favour of such a cable. Still, there are one or two points we should like to refer to at the present juncture. As the *Chronicle* puts it, the existing cable route to the East is practically controlled by Sir J. Pender. The lines so controlled have been constructed and carried on with a view to absolute monopoly. The game of playing men against men in order to retain this monopoly, of getting the ear of the Press, of pitting nation against nation, has been skilfully played; we will say nothing of the conscientious methods pursued, for they are too often conspicuous by their absence. Far better had these monopolists understood the march of progress, then their opposition to the inevitable would have been tempered with reason. They have long argued that lines with infrequent stations could never pay; that in case of war the short lines could be more easily defended, and, if injured, more easily repaired; that, if necessary, short splices could more easily be made to shut out of circuit any given port; and that competition would ruin both parties. They have never put forward the fact that to accomplish their ends they have completed a system in which many vital points would be in the hands of enemies in the case of war. When compelled to admit this or that point would be so, they contend alternative routes would be open, forgetting that these alternative routes have also points in the hands of possible enemies. If any dispassionate and unbiassed observer will take a map of the world and try to find a means by which England could communicate with the various Colonies in the time of war without foreign supervision, we think that that observer will come to the conclusion we have expressed. Sir John Pender is great upon the millennium being brought about by the aid of cables, and that the linkages by cable must bring about the friendship of nations. This is unmitigated nonsense. The sole consideration is self-interest. If it pays men to believe this twaddle, they will do so. The importance of the Pacific cable is that it forms a link in the cable system which will enable England to communicate with her Eastern Colonies without the line of communication anywhere touching hostile territory. From our point of view, the proposed line should be absolutely independent of the existing system, and we hope to see the day when Australia will be connected direct to London by a system of lines that shall be under the control of Englishmen only. The existing Atlantic lines from this country are not of this class. Pooling has made them common property. It is to the interest of England and her Colonies in these days, when Imperial interests are becoming more and more important, to be what we might term self-contained. We trust, then, that the favourable views of Mr. Chamberlain will lead to action in the near future. He, as a business man, goes straight to the point of the capital expended being remunerative, and if convinced in this direction, the sooner the work is undertaken the better.

HIGH AND LOW PRESSURE.

Whatever may be the opinion of individual engineers as to the merits of the new regulations proposed by the Board of Trade, it must be universally admitted that the rules have not been passed without open discussion. The revised regulations and the amendments proposed to them by the various engineers and corporations interested have been most carefully gone through in the conference held at the Westminster Town Hall this week. The discussion is reported fully in our columns. We propose to leave the summary of the concessions gained until next week. The definition of terms which preceded the regulations, and which form the subject of this leader, gave rise to a most important discussion. The Board of Trade proposed that all pressures over 300 volts with direct currents, and 150 volts with alternating currents, should be considered as high pressures and treated as such. The real point at issue, however, hinged on the fact that a subsequent rule stated that all high-pressure mains should be insulated throughout. Therefore, if 200-volt lamps were used on the three-wire system, the use of bare copper strip in culverts would be forbidden. The replacement of mains already constructed with bare copper would cause a very large outlay in many of our most important electric lighting undertakings. In consequence, the term "low pressure," as defined above, was strenuously opposed by all station engineers, and few supporters were to be found to prove that pressures over 300 volts in private houses would be dangerous. We fully agree that with ordinary precautions there is no danger from using 500 volts between the extreme wires of three or five-way systems. From the amendment as eventually adopted for the consideration of the Board of Trade, it seems likely that the 300-volt limit will be adopted in a form which prohibits this pressure being exceeded between any conductor earthed or between any two adjacent wires of the three and five wire system. This will allow of a 600-volt difference of pressure between the outside conductors, and will also permit of the use of high-voltage lamps.

WHAT, WHEN, AND WHERE.

Institution of Electrical Engineers.

November 28, 8 p.m.—At 25, Great George-street, Westminster. Ordinary meeting.

Society of Arts, John-street, Adelphi, London, W.C.

November 27, 8 p m.—Second ordinary meeting, "Locomotive Carriages for Common Roads," by H. H. Cunynghame.

Northern Society of Electrical Engineers.

November 25.—At the Palatine Hotel, Hunt's Bank, Manchester. 7.30 p.m., council meeting; 8 p.m., ordinary general meeting. "The Use of Dust Destructors as Steam Producers for Electricity Supply Stations," by E. Manville.

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THE REVISED REGULATIONS OF THE BOARD OF TRADE.

A largely-attended meeting of representatives of municipal corporations, electric lighting companies, electrical engineers, and others interested was held at the Westminster Town Hall on Tuesday, under the presidency of Sir Courtenay Boyle, K.C.B., to consider the draft of the revised regulations of the Board of Trade in reference to electric lighting. The chairman was supported on his right by Major P. Cardew, R.E., the electrical adviser to the Board of Trade, and on his left by Mr. W. H. Preece, C.B.

In opening the proceedings, the CHAIRMAN said the Board of Trade had found it necessary to revise the regulations made under the Electric Lighting Acts of 1882 and 1888, and they had thought it convenient and desirable to give everyone who had raised any objections to the revised regulations an opportunity of stating what those objections were and of supporting them by verbal argument. The Board, he thought, had been amply justified in taking that course by the large and influential assembly that had come together. The responsibility of issuing regulations was devolved upon the Board of Trade by statute, and the Board could not divest themselves of it, but before issuing the new regulations they would carefully weigh every argument or any point which might be brought before them. With reference to the representatives of some of the telephone interests whom he saw were present, it might be well to say that the telephone interests would not be affected in any way by the regulations they were about to consider.

We give below the draft revised regulations, which also appeared in our issue of June 7, and append to each section the written amendments sent in to the Board of Trade for that section. These amendments are followed by the speeches of the gentlemen supporting them and the replies of the chairman and Major Cardew to the points raised. *Note.*—The regulations are give in larger type than the amendments, speeches, etc., which follow them.

Mr. C. Hammond enquired if the new regulations would be retrospective, and was informed that each clause would be considered by itself as to whether it should apply to work already carried out.

ELECTRIC LIGHTING ACTS, 1882 AND 1888.

DRAFT REVISED REGULATIONS.

Definitions.

In the following regulations—

The expression "the order" means the ——— order.

The expression "the undertakers" means the undertakers for the purpose of the order.

The expression "consumer's wires" means any electric lines on a consumer's premises which are connected with the service lines of the undertakers at the consumer's terminals.

The expression "aerial line" means any electric line which is placed above ground and in the open air.

The expression "pressure" means the difference of electrical potential between any two conductors through which a supply of energy is given, or between any part of either conductor and the earth; pressure on any alternating-current system being taken to be the equivalent of pressure on a continuous-current system when it produces an equal heating effect if applied to the ends of a thin stretched wire or carbon filament; and (*a*) where the conditions of the supply are such that the pressure cannot at any time exceed 300 volts, if continuous, or the equivalent of 150 volts, if alternating, the supply shall be deemed a low-pressure supply. (*b*) Where the conditions of the supply are such that the pressure may exceed the limits of a low-pressure supply, but cannot exceed 3,000 volts, or the equivalent of 3,000 volts, whether continuous or alternating, the supply shall be deemed a high pressure supply. (*c*) Where the conditions of the supply are such that the pressure may on either system exceed 3,000 volts, or the equivalent of 3,000 volts, the supply shall be deemed an extra high-pressure supply.

Mains, service lines, and other conductors and apparatus are referred to as low-pressure, high-pressure, and extra high-pressure mains, etc, according to the conditions of the supply delivered through the same or particular portions thereof.

Where these regulations require any metallic body to be "efficiently connected with earth," it shall be connected with the general mass of earth in such manner as will ensure at all times an immediate and safe discharge of electrical energy.

Other expressions to which meanings are assigned in the Order or principal Act have the same respective meanings in these regulations.

AMENDMENTS.

Definition—"Pressure" (*a*) in conjunction with Regulation 1.

British Insulated Wire Co.—Apparently prohibits taking of an alternating service into a building on the three-wire system at 200 volts between the outer conductors. Point out that the danger of shock to the person is the same where a two or three wire service is used from a three-wire network, which is apparently not prohibited.

Notting Hill Co.—300 volts should be increased to 600 volts.

Dover Co. and County of London Co.—That the pressure should be raised to 440 volts for continuous current, and 220 volts for alternating current.

Hanley Corporation.—200 volts should be substituted for 150 volts alternating in order that the three-wire system may be used for low-pressure mains. The idea that alternating current is more dangerous than continuous to the extent presumed in the regulations is a mistaken one.

Institution of Electrical Engineers.—Wording of definition of pressure between two conductors to be amended to make matters clearer (no amendment suggested). Wording to be made clear that with three-wire system 200 to 250 volt lamps may be allowed. Voltage should be raised to 600 volts continuous, and equivalent of 500 volts if alternating. Support general desire of the profession to use glow and incandescent lamps taking from 200 to 250 volts at their terminals.

London Chamber of Commerce—The clause should be amended so as to define its application to three-wire and other multiple systems.

Manchester Corporation.—The omission of the following proviso, which was contained in the old regulations, makes their system a high-pressure system In order to comply with the requirements for high pressure, the Corporation would have to remodel the whole of generating station, and relay greater part of conductors. Moreover, Board of Trade have approved of their system as a low-pressure supply. "Provided that in the case of conductors laid under the surface of the ground in conduits, in accordance with these regulations, and being the property or under the sole charge of the undertakers, 'low-pressure conductor' shall mean any conductor in which the pressure between that conductor and the earth cannot at any time, if continuous, exceed 300 volts, or if alternating, 150 volts, or between that conductor and any other conductor laid in the same conduit cannot at any time, if continuous, exceed 500 volts, or if alternating, 250 volts." If the proviso is omitted, suggest that clause (*a*) be altered to read "where the conditions of supply are such that the pressure cannot at any time exceed 500 volts (? 450) if continuous . . . the supply shall be deemed a low-pressure supply." Urge that Manchester be exempted from operation of new regulations so far as the system (a five-wire system) is concerned (hitherto defined as a low-pressure system), or that the definition of high pressure and low pressure may be so modified as to continue Manchester as a low-pressure supply, to apply to all future extensions of the five-wire system in Manchester. Offer evidence.

Glasgow Corporation.—Definition of low pressure to be raised, so that at the least 200-volt lamps may be used.

Northern Society of Electrical Engineers.—To read, "Where the conditions of supply are such that the pressure cannot at any time exceed 500 volts, the supply shall be deemed a low-pressure supply."

Definition.—Pressure (*a*), (*b*), (*c*), in conjunction with Regulation 1.

London Chamber of Commerce.—The voltage should be raised to 500, and no distinction should be made between alternating and continuous current systems.

On behalf of the British Insulated Wire Company, Limited, **Mr. Nesbitt** supported the amendment given above, and stated that the regulations would condemn many systems now at work.

Mr. R. E. Crompton, who throughout represented the Institution of Electrical Engineers, which has considered these regulations in committee, said that the recent improvements in the manufacture of incandescent lamps had resulted in reliable lamps being produced to work at pressures of from 200 to 220 volts. On the three-wire system this would mean a pressure of 440 volts between the outside wires. This was one of the most marked improvements of the last four years, and everyone was anxious to make use of the advantages to be derived from the higher pressure. The Council of the Institution considered that 600 volts was a safe pressure, and therefore it should be allowed. He would point out that the Board of Trade had allowed 500 volts to be used for systems of electric traction, and he considered the dangers incident to a lighting system were less than from a traction system at the same pressure. He had had experience of the shock from 600 volts, and he did not consider it would permanently injure a man in good health. He knew that there had been a few cases of death resulting from a shock at lower pressures, but he considered that the united experience of the world showed that these cases were due to weak heart. The majority of electrical engineers held that 600 volts was a safe pressure, and the adoption of that limit would greatly simplify the systems of distribution and be of enormous benefit to the electrical industry.

Mr. Musgrave Heaphy, speaking on behalf of the Phœnix Fire Office, stated that he would much prefer the 300 volt limit should remain in the regulations.

Mr. Alexander Siemens, arguing on the ground that experience had so perfected the manufacture of boilers that high steam

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pressures could be used with safety which would have been formerly quite impossible, said that he considered a higher limit for electric pressure quite safe. He mentioned an instance in which a workman had taken a shock from an alternating-current supply at 2,000 volts for half a minute without receiving permanent injury. It depended on the condition of the subject whether a shock would be fatal or not. In view of the progress of the electrical industry, he advocated making the limit higher than in the old regulations.

Prof. A. B. W. Kennedy remarked that there were a great many undertakers who had deliberately adopted the three-wire system at 200 volts, with the distinct knowledge that in five or ten years they would be able to use lamps of 200 volts or higher pressure, and that gave a pressure of 400 to 450 volts between the outside wires, or, say 500 volts at the terminals of the dynamo. These systems had been adopted in the knowledge that it would be advantageous later on to use high-voltage lamps when it became possible to get them, and he must say he agreed with Mr. Crompton that the higher limit was quite a reasonable one He believed that in the future they would have 300 volt lamps, though at present he had not seen any, and he therefore hoped that the Board of Trade would give them the very highest limit consistent with safety. That would tend to economy of distribution, and therefore would cheapen the light, and be for the advantage of the public.

Dr. John Hopkinson referred to Manchester as a place where the troubles due to a higher pressure would have been noticed. They used there the five-wire system, with 450 volts between the two extreme wires. They had spent £175 000 up to last March, and now had almost expended the £100,000 obtained as an extra since then. They had had no trouble; they had set no buildings on fire; they had hurt no one; and they had given full satisfaction to consumers. They had at Manchester 937 consumers wired and they had never had a single complaint of a shock causing anyone inconvenience. They had thus been working advantageously with a pressure at the terminals of 450 volts, and he considered that was good evidence in favour of an extension of the limit up to something like 500 volts. They had worked the system with very great success financially, and there was no town in which there was such a large percentage of profit shown as was done at Manchester. They wanted to give the public the electric light cheaply, and it would certainly be exceedingly hard to interfere with Manchester doing what they had done hitherto with marked success.

The **Chairman** doubted whether the present system at Manchester would comply even with the present rules.

Mr. E. Manville said that he did not approve of the difference between the limits of pressure laid down by the Board of Trade for alternating and direct currents respectively. He did not consider alternating currents more dangerous than continuous currents, and would like the limit of pressure to be the same in each case.

Alderman Higginbottom, the chairman of the Manchester Electric Lighting Committee, pointed out that they had 89 miles of bare copper mains already laid, which would have to be reconstructed with insulated cable unless the limit of pressure was raised.

Earl Russell, who represented the London County Council, said that that body would not approve of a pressure of 450 volts being introduced into buildings. He would like to suggest that there should be in the regulations some intermediate class between low pressure at 300 volts and high pressure at 3,000 volts. That was a considerable jump to make at once

Prof. Ayrton said it was not clear what was meant by the term "difference of electrical potential between any two conductors through which a supply of electric energy is given" It was a question whether this referred to any two conductors in a house or in the system of mains. Assuming that it meant that 300 volts would be allowed between two conductors in one house and 300 volts between the conductors in the next house, it would give 600 volts between the mains in the culvert. If then, the middle wire was earthed, the maximum shock which could be obtained in the house would be one of 300 volts

Mr. Morse, who appeared on behalf of the Chamber of Commerce, thought that the clause should be amended so as to define its application to three-wire and other multiple systems He proposed that after the word earth the following should be inserted: "or between any adjacent wires of the three or four wire system."

Mr. J S. Raworth was of opinion that the limit should be raised to about 500 volts, and that the alternating current should be put upon something like an equality with the continuous current He had had great experience of high-tension work in Hastings, where 1,800 volts were introduced into the houses without any accidents occurring.

Mr. Sayers, of Bournemouth, advocated the raising of the limit for alternating currents above 150 volts. When there was a scattered district with houses standing in their own grounds a three-wire system was much better for the service mains, as the heavy wires required for the two-wire supply were exceedingly costly. He thought that 220 volts alternating between the extreme wires taken into the houses would be quite safe. As regards fire risk, the alternating current was less dangerous than the direct because the arc gave less heat.

Major-General Webber thought that the question of a safe pressure might be deferred, and that it should be submitted to a committee of experts.

Mr. Holder, the chairman of the Electric Lighting Committee at Hull, referred to the fact that they were expecting to use electric traction on their tramways. The limiting tension allowed on the tramways being 500 volts, it would be a great advantage to be able to work the light and power with the same machinery. He referred to the recent improvements in high-voltage incandescent lamps, and stated that Mr. Gibbons, their late electrical engineer, had succeeded in obtaining 8-c.p lamps to work commercially on 200-volt circuits.

Mr. J. Hesketh of Blackpool, said that his experience with the tramway there, which was worked at 250 volts, showed that there was no danger at that pressure.

Prof. Ayrton said he was prepared to accept Mr. Morse's amendment.

Major Cardew said that the question of what was to be considered high pressure depended upon other considerations than that of danger to human life. He did not say that in selecting 300 volts for a continuous current they had not arrived at a limit which might very fairly be the discriminating point between a pressure which might be dangerous and a pressure which might be taken with impunity. Many people could take a shock from more than 300 volts It all depended on the state of the skin, and no regulations could provide people with skins The regulations provided that low-pressure conductors need not be continuously insulated in the streets. Now they knew that there were certain dangers of corroding pipes, and the possibility of explosions and fires, and if they increased the pressure they must increase the risk of incurring these dangers. With the exception of Manchester, he thought the direct-supply systems had not been very free from these dangers on the whole. There had been regrettable accidents. The one at St. Pancras must be in the mind of everyone. At Southampton there had been an explosion, also on the St. James's and Pall Mall, on the Preston system, and on several others. Mr. Crompton had stated that in certain cases 500 volts had been allowed for traction purposes. But he could not agree with Mr Crompton that this was more dangerous in the street than in houses. Up to the present all the speakers had dealt with the subject from the point of view of the suppliers. No one had represented that the consumers were anxious to have 200 volt lamps, even if they were supplied gratis. All the advantages from the use of these lamps were on the side of the supplier. The only accident in the Board's experience in the British isles which throws light on the desirable limit was the late lamentable accident at Portrush The pressure there could not have exceeded 320 volts. The man was thrown upon the track and remained in contact with the rail for some considerable time. The doctors' evidence at the enquiry showed that in their opinion if the electrical shock had not been added to the mechanical shock, the man would not have succumbed. There had also been numerous instances of deaths of horses and cattle at a pressure of 300 volts.

Mr. Alexander Siemens, who had been a member of the committee of enquiry into the St. Pancras explosion, did not agree with Major Cardew in assuming that the trouble would be augmented with the increase of pressure He believed that the electrolytic action would have occurred just as much if only 50 volts had been used.

In summing up the matter, the **Chairman** said that the Board of Trade would carefully consider the suggestions and amendments He personally was of opinion that the limit could be slightly raised both for alternating and direct currents.

(1) Save as hereinafter provided, the supply of energy delivered to the consumer's terminals shall be a low-pressure supply.

(2) A high-pressure supply shall not be delivered to any consumer's terminals, except for special purposes, and with the approval of the Board of Trade on the joint application of the consumer and the undertakers, and subject to such further regulations as the Board of Trade may from time to time prescribe. But a high-pressure supply may be given to distributing or converting stations or to transforming apparatus on a consumer's premises in accordance with the following regulations.

Southport Corporation.—For "except for special purposes, and with the approval, etc," read "except for experimental purposes without the approval, etc."

The **Representative** of the Southport Corporation moved that for "except for special purposes, and with the approval, etc.," read "except for experimental purposes without the approval, etc.," and the **Chairman** said the Board of Trade would consider the amendment.

(3) An extra high-pressure supply shall not be given except to distributing stations or other premises in the sole occupation of the undertakers, and with the written consent of the Board of Trade, and subject to such regulations and conditions as the Board may prescribe.

(4) No high-pressure electric line shall be used for the transmission of more than 200,000 watts, or in the case of an aerial line 50,000 watts, except with the consent in writing of the Board of Trade, and efficient means shall be provided to prevent this limit being at any time exceeded.

Bournemouth Co.—200,000 watts is too low, and at 2 000 volts pressure is under the economical size of conductor. Suggests 300,000 watts.

British Insulated Wire Co.—If the maximum size of cable were put at 300,000 watts, it would much more generally accord with practice, as many stations have ·15 cables in use to a large extent.

Dublin Corporation.—The term "line" should be defined. Does

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it mean "cable"? If so, it should be stated, so that when a larger supply is needed it can be given by duplicating the cables.

Halifax Corporation.—Presume term "electric line" includes feeding and distributing mains, aerial wires, service lines, and house wires.

Dover and County of London Co.—Instead of maximum of 200,000 watts for an underground line, the current should be limited so as not to exceed 150 amperes for high pressure, which for 2,000 volts, with a variation of 10 per cent. in pressure, would give 375,000 watts as the limit. The effect of the clause as drawn would be to increase the number of mains in a district in which there is a heavy demand for current, and so to increase the difficulties as to insulation If the object of the clause is to make it correspond with old regulation (3) think companies would have no objection to provide duplicate mains where the energy would on any one circuit exceed 200,000 watts.

St. James and Pall Mall Co.—Limit of 200 000 watts on a high-pressure line is too low—*e.g.*, a proper and convenient section for such a cable on 1,000-volt continuous-current transmission would be 0·5 square inch cross-section of conductor. It is understood that such a main would consist of two or more cables to ensure continuity of supply in the event of injury to any one cable.

Southport Corporation.—Contend for use of high pressure concentric cables capable of carrying a current of 400,000 watts, and a cable having a sectional area of ·2.

Wolverhampton Corporation.—"Electric line" is not defined. Limit of 200,000 watts is unnecessarily low.

Hanley Corporation.—Limit of 200,000 watts is too low. The Corporation give instances where in their own system the limit would be inconvenient. They also refer to the inconvenience in the case of electric traction.

Institution of Electrical Engineers.—For 200,000 substitute 500,000.

London Chamber of Commerce.—The limit of 200,000 watts should be increased.

Chelsea Co.—The limit of 200,000 watts is too low. Suggest 400,000.

Charing Cross and Strand Co.—The limit of energy on any high-pressure line might be raised to 500,000 watts. This would admit ·50in. conductors on 1,000 volts or ·250in. on 200 volts. The multiplication of separate conductors on trunk lines is to be avoided as far as possible.

Portsmouth Corporation and Shoreditch Vestry.—In the case of a high-tension system (2,000 volts) limit provided in the case of an underground electric line would soon be reached. Conductors may be ¼in. section, and might with economy be used for transmission of more energy than that stipulated.

Manchester Corporation.—Alter to read: "No high-pressure electric line shall be used for the transmission of more than 330,000 watts, or in the case of an aerial line 50,000 watts except with the consent in writing of the Board of Trade, and unless such excess is of short duration, and is necessary for the maintenance of supply." Should their system be declared a high-pressure system (see remarks on definitions), and Clause 4 be enforced, they would not be able to fully employ the feeders already laid, or to work their engines and dynamos at full load.

Northern Society of Electrical Engineers.—Omit entirely.

Mr. H. M. Sayers, of Bournemouth, considered the 200 000-watt limit too low, as at 2,000 volts it was under the economical size of conductor. He would suggest that it be raised to 300 kilowatts.

Mr. Crompton moved the amendment proposed by the Institution of Electrical Engineers, that the limit be raised to 500 kilowatts, and said that there was no trouble in providing efficient automatic cut-outs.

The **Chairman** said he was willing to accept the alteration to 300 kilowatts, and suggested that the matter should be allowed to adjust itself commercially under the Board of Trade jurisdiction, as the clause allowed of special cases being considered separately.

Lord Russell hoped that the extension of the maximum would be limited to cases where concentric cables were used.

Major Cardew said that the danger was as follows: If there was an electric line conveying some 300 h.p. or 400 h.p., and a fault occurred at one point of the line, there might be a sudden development of heat equivalent to that horse-power at the point where the fault occurred. Under those circumstances something was bound to happen, and the possible effects were exemplified by the Cannon-street accident. In the Sloane-square explosion the sudden development of heat was sufficient without any gas being present to cause an enormous expansion of the air in a confined space, which lifted up the cover of the street box and threw it several feet away. He thought the proposed limit was reasonable.

The **Chairman** said that the matter would be carefully considered, but he did not think that the maximum could be safely raised to 500 kilowatts.

(5) Every high-pressure electric line, conductor, or other apparatus shall be protected by a suitable automatic quick-acting cut-off.

British Insulated Wire Co.—That some directions should be inserted for the guidance of undertakers using a system in which the outer conductor is connected to earth. Quote cases in which, on such a system, a fuse has been used on each conductor, and, owing to weakness of the fuses or an overload, the fuse on the outer has gone, and the outer conductor of the cables and transformers or machine has been charged up to the full working potential above that of the earth, with consequent damage to the insulation.

Dublin Corporation.—Assume that a safety fuse will meet the regulation. That the clause as it stands is very vague.

Sheffield Co.—The outer conductor being earthed, conclude that the provision of an automatic cut-off refers to the inner conductor only.

Manchester Corporation.—Omit entirely. The sudden cutting off of a main, causing extinction of all lights connected to it, is to be avoided. The excess current might be due to a fault which would disappear in a few seconds if the mains were not disconnected.

Mr. Nesbitt, of the British Insulated Wire Company, thought that some directions should be inserted for the guidance of undertakers using a system in which the outer conductor was connected to earth. He knew of cases in which, on such a system, a fuse had been used on each conductor, and, owing to weakness of the fuses or an overload, the fuse on the outer had gone, and the outer conductor of the cables and transformers or machine had been charged up to the full working potential above that of the earth, with consequent damage to the insulation.

The **Chairman** said that the case would be met by having no fuse on the outer conductor.

Dr. John Hopkinson said that under the old regulations they were required to use fuses in the Manchester network. He had designed and provided fuses for this system, but had not ventured to put them in for fear of extinction of the lights. He proposed that the regulation should be omitted.

Prof. Kennedy said if a 200-volt lamp made a high-pressure system of the present three-wire arrangement the clause would seriously handicap the industry, as the fuses were decidedly not wanted.

(6) In every case where any transforming apparatus is used to convert a high-pressure supply into a low-pressure supply, some suitable automatic and quick-acting means shall be provided to protect the low-pressure system from any accidental contact with or leakage from the high-pressure system, either within or without the transforming apparatus.

Bournemouth Co.—Question whether such automatic means are really needed when earth-shielded transformers and earthed metallic shielding between H.T. and L.T. conductors are everywhere employed.

Sheffield Co.—Assume that the provision of transformers which are completely enclosed in metal cases with an iron screen between the primary and secondary windings connected to earth meets the requirements of this regulation.

Southport Corporation.—Presume proper fuses are referred to.

London Chamber of Commerce.—In the absence of any known suitable device of the kind described the clause should be omitted.

Phœnix Fire Office (Transformers).—"It may be of interest to you to know that since the use of the Cardew safety device not a single instance of the high-pressure current getting into the low-pressure system in any building insured with this company has come before us."

Manchester Corporation.—Omit entirely. With a pressure of 400 volts it is unnecessary.

(7) The maximum working current in any conductor shall not be sufficient to raise the temperature of the conductor or any part thereof to such an extent as to materially alter the physical condition or specific resistance of the insulating covering, if any, or in any case to raise such temperature to a greater extent than 30deg. F.; and efficient automatic means shall be provided which will render it impossible for this maximum working current to exceed such limit to the extent of 50 per cent., even for short intervals of time; and special care shall be taken that the cross-sectional area and conductivity at joints are sufficient to avoid local heating, and that the joints are protected against corrosion.

British Insulated Wire Co —Assume that in future fuses on the low-tension network will be a necessity.

St. James's and Pall Mall Co.—The meaning of the clause is not quite clear in reference to a low-pressure distribution, and the use of quick-acting automatic cut outs on a low-pressure network might be attended with serious results from an unnecessary stoppage of supply.

Institution of Electrical Engineers.—Omit "or in any case to raise such temperature to a greater extent that 30deg. F., and efficient automatic means shall be provided which will render it impossible for this maximum working current to exceed such limit to the extent of 50 per cent., even for short intervals of time."

London Chamber of Commerce —Should be omitted, as it is covered by Clause 5.

Phœnix Fire Office —It would be better to state a temperature above which a conductor should not be raised in the event of 50 per cent. above the maximum working current being sent through it.

Manchester Corporation—Omit "and an efficient automatic means shall be provided which shall render it impossible for this maximum working current to exceed such limit to the extent of 50 per cent. even for short intervals of time." Consider the requirement prejudicial to the interests of consumers, as should there be a momentary increase of current from any cause, undertakers would be compelled to cut off supply, and put a portion, if not the whole, of their system in darkness. The result in the case of theatres, etc., might be disastrous.

Northern Society of Electrical Engineers.—Omit entirely.

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Clauses 6 and 7 were discussed together.

Mr. Sayers, referring to the observation of the Bournemouth Company, pointed out the impossibility of any dangerous contact if the earthed metallic shield between the high and low pressure was adopted.

The **Chairman** said that the earthed shield was considered to be an automatic device under the clause.

Mr. Wright (Brighton) asked if earthing the middle wire would constitute an "automatic means."

The **Chairman**: I am advised not.

Dr. John Hopkinson, for Manchester, said the clause was an old one. In the large majority of low-tension stations it had not been carried out, because it was felt that they were far better without cut-outs. A law that was constantly transgressed with impunity was better revoked. He moved the omission of all from the word "efficient" down to the word "time."

The **Chairman** said he was advised that that could be done.

(8) The sectional area of the conductor in any electric line laid or erected in any street shall not be less than the area of a circle of one-tenth of an inch diameter, and when the conductor is formed of a strand of wires each separate wire shall be at least as large as No. 20 standard wire gauge.

Burnley Corporation.—Line 1, after "electric line" insert "hereafter." Submit that regulation should not apply to wires already laid down, which in some cases are of a less diameter than than that described.

Bolton Corporation.—They comply with the regulation except in the case of pilot wires; but as these wires do not convey energy to the public, perhaps the regulation does not apply. (Sample of wire enclosed.)

London County Council.—The regulation permits the use of wires in stranded conductors as small as No 20 standard wire gauge. Suggest that the smallest wire to be used shall not be less than No. 16, or in any case not less than No. 18.

Walsall Corporation.—It should be made clear that the regulation does not apply to pilot wires, or to wires used for telephonic purposes.

Cardiff Corporation.—Their arc light cables do not comply with this regulation. The strand of wires therein is composed of 47 wires. No. 23 standard wire gauge

Dover Co. and County of London Co —Suggest that wires in a strand should not be less than No. 18 standard wire gauge. Company limit size to No. 16, having found cables containing wires of No 20 gauge liable to break down in use.

Lancaster Corporation.—Suggest that regulation apply only to conductors hereafter laid, and that word "hereafter" be inserted after "electric line" Wires of diameter slightly less than that prescribed have been laid in Lancaster, and to replace them would cause much expense and inconvenience.

Blackburn Corporation —Pilot wires should be excepted

Hanley Corporation.—Suggest addition of words, "except with the consent in writing of the Board of Trade." This regulation will prevent the lighting of one, two, or three street lamps of 16 c p. each through a smaller cable than $^{7}/_{20}$ S.W.G. This is manifestly unnecessarily large. The requirement that each separate wire shall be at least as large as No. 20 S.W.G. will be found particularly inconvenient in the case of concentric cables. $^{7}/_{20}$ is unnecessarily large for pilot wires and pressure wires

Institution of Electrical Engineers.—Omit regulation and substitute, "Every cable or test wire laid or erected in any street must be of sufficient mechanical strength to enable it to be brought into position without injury."

London Chamber of Commerce.—Similar to observations made by Institution of Electrical Engineers above.

Charing Cross and Strand Co.—Pilot or pressure wires should be excepted.

Glasgow Corporation.—Pilot wires should be exempted from the operation of this clause. There is no practical necessity in making them as large as the minimum defined

Northern Society of Electrical Engineers —Add 'except pilot wires and in junction-boxes or other situations where extreme flexibility is necessary."

Eastbourne Co —Company have a considerable quantity of cable of less section than that specified, and substitution of another of larger scale would entail an uncalled-for expenditure. Where these cables are in use they are worked at a moderate current density, and are sufficiently large for the purpose required, such as for service mains into houses and for supplying a few houses in an outlying district.

The **Chairman** said that the amendment from Burnley might be accepted, thus making the clause prospective only.

(9) Every electric line shall be tested for insulation after having been placed in position, the testing pressure being at least 200 volts, and the undertakers shall duly record the results of the tests of each line or section of a line. No electric line shall be brought into use in which this test indicates an insulation resistance less than at the rate of 100,000 ohms per mile for every volt of pressure of the supply, unless it is connected with earth with the consent of the Board of Trade, in which case the insulation resistance of such electric line shall not be less than 10 megohms.

Bournemouth Co.—Where concentric cables are used, is the insulation of the outer conductor to conform to this regulation or only that of the inner conductor? 10 megohms. Is this to be the minimum insulation of the whole high-pressure system regardless of extent, or per mile of cable? If the former, the standard is higher than experience proves possible or necessary.

Burnley Corporation.—That low pressure service lines should not be included in the regulation, and that whenever the cable for service lines has been tested on the drum it should not be necessary to again test the separate lengths when cut off. The apparatus would be costly and cumbersome for street use

National Electric Supply Co.—The regulation as it stands would prevent the employment of bare copper systems, as in use at Preston, which work perfectly well in practice Their insulation does not reach the required figures, but the company have had no trouble therefrom

British Insulated Wire Co.—The 200 volt testing pressure is unusual, and will tend to upset present arrangements. The usual testing pressure is only 100 volts, batteries being arranged in sets for the purpose.

Halifax Corporation —The regulation is vague. Assuming that "electric line" includes a network, consisting of feeders, distributing main, service line, and house wires it would be practically impossible to obtain, with a testing pressure of 200 volts, so high an insulation resistance as that prescribed; or, assuming that "electric line" is a service line laid and about to be jointed to a network, a test of the service line alone would be of little practical use, as the fault, if any, would probably occur at the joint.

London County Council.—Some further definition seems to be required as to when, how, and by what means the tests are to be made, or all these matters might be left by the regulations to be approved in detail by the Board of Trade

Burton on-Trent Corporation —If "every electric line" is to include consumer's wires, such wires will be incapable of standing the proposed test. In the case of "service lines," is the test to be made after they are jointed to the low-pressure mains? If so, and the consumer's wires are excluded from the testing, it will be necessary to switch off all the consumers The whole of the low-pressure distributing mains and service lines on that section would then be tested and whether after or before the test, expense would be caused in providing a generator or battery, which will be very cumbersome to carry about. Corporation now use the ordinary "Silvertown set" for testing outside the works. Suggest that the voltage should be reduced and the words "electric lines" limited in their meaning to the undertakers' electric lines only.

Notting Hill Co.—Too severe. The minimum standard of 10 megohms can hardly be maintained; the more joints that are placed in a cable the lower will be the resistance to earth.

Yorkshire House-to-House Co.—It is not clear whether the insulation test proposed is intended to apply only to complete new circuits or is also to apply to additions to circuits. Company's pressure of supply being 2 000 volts, the minimum insulation resistance proposed to be required would be 200 megohms per mile, and they doubt whether it is practicable to obtain by means of portable apparatus such accuracy of testing as would be required in short lengths of main if the proposed regulation apply to such.

Ogmore Valley Co —Is 200 volts test necessary? Company's working pressure is 115 volts.

Lancaster Corporation.—Too stringent as regards low-pressure service wires and consumers' wires. To ensure that new consumers' wires should stand proposed test would seriously affect cost of private wiring and check adoption of the light. Apparatus required for proposed test would be costly to buy and cumbersome to use. Suggest that regulation shall not apply to low-pressure service lines not exceeding 20 yards in length, or to low-pressure consumers' wires and fittings.

Wolverhampton Corporation.—The testing E M F. of 100 volts in the old regulations is satisfactory, and no good purpose would be served by raising it to 200 volts.

Islington Vestry.—The wording of latter part of regulation is vague. If main is earthed, it obviously could not have an insulation resistance of 10 megohms.

Institution of Electrical Engineers.—Line 1, after "electr line" insert "except service lines" Line 5, before "electric line insert "high pressure." Line 7, for 100,000 ohms read 25 000. A end of regulation add "per mile before connecting to earth"

London Chamber of Commerce.—Same as Institution; also that clause is not clear.

Chelsea Co —A testing pressure of 200 volts is extremely inconvenient, an effective battery of such an E.M.F. not being sufficiently portable; 100 volts should be sufficient for continuous currents.

Glasgow Corporation.—Clause is exceedingly stringent. Quite impossible to lay bare copper strip and fulfil the conditions of insulation resistance imposed here. At best it could only be a laboratory test and, for working purposes, of no value. The maximum leakage allowed in next clause can very easily be complied with with a very much lower test for insulation.

Charing Cross and Strand Co.—The standard is too high for a line including several joints and connections. On a network including several thousand lamps connected this standard is impossible.

St. Pancras Vestry.—Figures given are far in excess of what may be got on a bare copper system of good design. For direct current and bare copper systems, the electrical osmosis speedily brings down the insulation to a low point on the negative.

Newcastle Co.—This could only be done before the line is brought into use. It would be well for Board of Trade to specify what they would consider suitable means for the immediate indication of faults of insulation.

Portsmouth Corporation and Shoreditch Vestry.—Intention of latter part of regulation not clear. If system be connected to

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"earth" it is impossible that there can be greater insulation resistance than that represented by the resistance of the conductor itself from its extreme end to point at which it is connected to earth. Neither is it stated whether the "10 megohms insulation resistance" refers to the total length of a circuit, or if not, to what length. A long circuit with a number of large street-box transformers would involve difficulties in maintaining an insulation resistance inclusive of the transformers of 10 megohms per mile.

Westminster Co..Edinburgh Corporation, Aberdeen Corporation, Belfast Corporation, Oldham Corporation, and Sunderland Corporation —That the condition is a prohibitive one Although condition forms part of old regulations have not heard of any attempt to enforce it. Doubt if there is any system of mains in which the required insulation can be obtained without the warming up of end connections and the taking of other special means to bring up the insulation, which practically deprives the test of all real value.

Manchester Corporation.—Alter to read as follows: "Every electric line shall be tested for insulation after having been placed in position, the testing pressure being at least 200 volts, and the undertakers shall duly record the results of the tests of each line or section of a line. No electric line shall be brought into use in which this test indicates an insulation resistance of the insulating material exclusive of surface leakage less than at the rate of 100 000 ohms per mile for every volt of pressure of the supply, or (less than) at the rate of 1 000 ohms per mile for every volt of the pressure of the supply including surface leakage, unless it is connected with earth with the consent of the Board of Trade, in which case the insulation resistance of such electric line shall not be less than one-half the quantities above named." The high-insulation resistance *per se* is not essential to safety. The magnitude of the insulation resistance depends entirely upon the material used for insulating. If this material be indiarubber, a low-insulation test would show bad quality. If paper, the insulation might be much lower, and yet the cable be equally safe; and if bare copper be employed, the insulation resistance might only be $\frac{1}{100}$ of that of rubber-insulated cable, and yet the system would be as safe.

Northern Society of Electrical Engineers.—In line 1, after "line" insert "except service lines." Line 3, for "200" read "100." Omit paragraph commencing "No electric line" and ending with "megohms."

Mr. H. M. Sayers moved the Bournemouth amendment, and asked for a definition on the subject whether the 10 megohms applied to the whole system.

The **Chairman**: It applies to the whole system

Mr. Sayers said that meant a different standard for a small system than for a large one.

Major Cardew said the regulation only required that a test should be taken of new cables when they were put in, and it was intended to ensure that a high standard of cable was laid.

Mr. Sayers thought there should be a standard per mile, and suggested 50 megohms.

Mr. Hammond thought the point referred to by Major Cardew should be made clear by adding the words "before it is connected with the apparatus."

The **Chairman**: I will accept that

Lord Russell suggested some such expression as "length of wire or main"

The **Chairman**: I like Mr. Hammond's words.

Mr. Nesbitt thought it should be left to the engineer to decide whether he would lose the leakage in a mile of cable or in six inches of porcelain.

The **Chairman** said the Board would consider if it was not possible to reduce the 100,000 ohms per mile.

Mr. Crompton said the Institution of Electrical Engineers had moved to insert the words "high pressure," as otherwise the whole clause would apply to low-pressure systems, and it would be absolutely impossible to carry it out. The alterations proposed by the Institution would make the clause workable. The insulation of a complete low-pressure system might vary from two or three ohms to 200 ohms at the best On the other hand, if the clause only meant that they were to test the cables before they laid them, why did it not say so? To speak of lines made the matter very obscure, and it was a fallacious test at the best, for a man might buy a very good cable and lay it so badly that it would fail. If the Board wanted to ensure a cable was well laid, they should apply a working test. With bare copper laid in conduits, the proposed test and standard was prohibitive, although such mains gave no trouble in practice.

Major Cardew said that the test was intended to ensure that care should be taken in drawing in the cables, and to provide against cables being accepted from the maker's test, and not being tested after they had been handled. The test was to be made immediately the cables were laid and before connections were made to them

Prof. Kennedy said that in certain circumstances, however good the cable might be, it would require what was vulgarly called "faking" to pass the test; for instance, the uncovered ends would have to be warmed up. If, however, the regulation referred to bare copper he would say that he had used many miles of it, and had had no trouble whatever from it, but at no time would it be possible to get on it any insulation resistance like the figure proposed—not even on the driest days. Yet he had never had any case where the limit of insulation came below the working limit His point was that there were many systems carried out with the consent of the Board of Trade which could not fulfil Clause 9, but which could easily fulfil Clause 10. The first was an old clause that had never been fulfilled so far as bare copper strip was concerned.

The **Chairman** said what was wanted was that when a cable was laid there should be some test. If they could help the Board to get that, he was prepared to meet the views expressed.

Prof. Ayrton asked if the clause applied to short service lines.

The **Chairman** said it did not. He would suggest an alteration reducing the 100,000 ohms to 25,000 ohms, and a provision that the regulation did not apply to short service lengths, say, of 20 yards.

A **Representative** from Liverpool said on their system, with bare copper mains and a few sections of cable, they could not get the insulation required by the clause.

Mr. Baynes said that the insulation required could not be obtained under any circumstances with the bare copper system. He would advocate rather a separate clause to deal with the bare copper system, and proposed that it should be based on a minimum insulation for each point of support

The **Chairman** then announced that he would advise the Board of Trade to amend and shorten the clause as follows: "Every electric line shall be tested for insulation after having been placed in position, and before apparatus is connected to it, the testing pressure being at least 200 volts, and the undertakers shall duly record the results of the tests of each line or section of a line."

(10) The insulation of every complete circuit used for the supply of energy, including all machinery, apparatus, and devices forming part of or in connection with such circuit, shall be so maintained that the leakage current shall not under any conditions exceed one-thousandth part of the maximum supply current; and suitable means shall be provided for the immediate indication and localisation of faults of insulation. Every such fault shall be remedied without delay. Every such circuit shall be tested for insulation at least once in every week, and the undertakers shall duly record the results of such testings. Provided that where the Board of Trade have approved of any part of any electric circuit being connected with earth, the provisions of this regulation shall not apply to such circuit so long as such connection exists.

Bournemouth Co.—Submit that on low-tension mains tests at much longer intervals than a week are sufficient. To maintain the insulation at the standard mentioned may involve much interference with consumers' installations, over which the undertakers have no effective power, especially if the low figure of 5,000 ohms is retained in Clause 45 Question how leakage current is to be distinguished from displacement or capacity current, in alternating current systems. A few miles of high-pressure mains give a capacity current measurable in amperes with the frequencies in general use.

Burnley Corporation.—State that, so far as their knowledge goes, it is impossible to provide apparatus for the immediate localisation of faults of insulation; also that it is impracticable to test the leakage current of low-distributing mains without disconnecting the consumers. Submit that regulations should provide that circuits may be tested for insulation by testing the leakage current to earth.

National Electric Supply Co—Should be modified so that where undertakers have an apparatus showing any variations in the insulation, a weekly test should not be required unless some fairly simple method is devised whereby the test can be taken without stopping the supply.

Dundee Gas Commissioners —Consider leakage current allowed is too small.

Notting Hill Co.—Regulation too severe.

Dover Electricity Co. and County of London Co —Inapplicable to an alternating-current system, since the condenser current on long lines is much more than the minimum specified, and is practically undistinguishable from leakage current.

St. James and Pall Mall Co—Clause does not say how the leakage current is to be ascertained; it is presumably by earthing either conductor and noting amount of current passing. Ask if such an earth connection is to be allowed. Eut in conjunction with Clause 45, undertakers might be compelled to make supply to any consumer having an insulation resistance above 5,000 ohms. If such an insulation resistance become at all general, the leakage current from this source alone would greatly exceed that allowed by Clause (10). Ask if undertakers have authority to insist on an insulation resistance in excess of 5,000 ohms.

Southport Corporation.—Paragraph 2: for "one week" read "two weeks."

Ogmore Valley Co.—Weekly tests unnecessarily frequent.

Lancaster Corporation.—Provisions are impracticable If a network of low-pressure mains is one "complete circuit," it is impossible to provide suitable means for the immediate indication and localisation of faults of insulation. If such a network consists of a number of complete circuits, each of which has to be tested once a week, a serious expense will be involved, and continual interruptions of the supply will be necessary. Suggest reconsideration of regulation, especially as regards its application to low-pressure distributing mains.

Blackburn Corporation.—Second paragraph. This is impossible on the low-tension system, and would necessitate disconnecting every consumer from the distributors one a week.

Wolverhampton Corporation.—Do not see how this can be applied to low-tension mains, as the leaks on consumers' premises are, together, usually considerable, and cannot be separated from the mains in practice.

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Institution of Electrical Engineers.—Paragraph 1: omit all words after "circuit" in line 4. Paragraph 2: omit, "Every such circuit," and for "at least once in every week" read "from time to time."

London Chamber of Commerce.—"Leakage current" should be better defined, and in lines 9 and 10 "from time to time" should be substituted for "at least once a week."

Chelsea Co.—No instrument obtainable which would ensure immediate localisation of faults.

St. Pancras Vestry.—Same remarks as made on regulation No. 9.

Newcastle Co.—Insulation tests to be taken once in every week. This is always a cause of complaint with consumers, who find it inconvenient to be cut off every week.

Westminster Co., Edinburgh Corporation, Aberdeen Corporation, Belfast Corporation, Oldham Corporation, and Sunderland Corporation.—The clause is so out of proportion to Clause 9 as to be inconsistent with it. In case of Westminster, Clause 9 would compel every main to test up to 20 megohms per mile after being laid and before being connected, while under Clause 10 the insulation of the whole distributing mains the next day and when actually at work might only be about 200 ohms per mile. Meaning of Clause 9 appears to be clear, and "leakage current" appears to mean actual leakage current while the mains are in their ordinary working condition, and not the current which can pass to earth when, say, the positive is momentarily earthed for the purposes of testing. The wording of the regulation might be made clearer.

Manchester Corporation.—Alter to read: "The insulation of every complete high-pressure circuit used for the supply of energy including all machinery, apparatus, and devices forming part of, or in connection with, such circuit shall be so maintained that the leakage current shall not, under any conditions, exceed one-thousandth part of the maximum supply current, and in the case of low pressure the insulation of the whole system, including the installations of consumers, and all machinery, apparatus, and devices shall be so maintained that it shall not fall below 1,200 megohms, divided by the number of watts in the maximum supply. Every fault shall be remedied without delay, and the undertakers shall keep a daily record of the insulation resistance. Provided that where the Board of Trade have approved of any part of any electric circuit being connected with earth, the provisions of this regulation shall not apply to this circuit so long as such connection exists." As the clause stands at present, it is not clear whether the test is to include the installations of consumers. If it is, the standard set up is much higher than could be attained if Clause 45 stands, as in the case of 1,000 consumers, each of whose installations is just above the minimum, the joint insulation resistance would only be five ohms, which would be the insulation of the circuit were the mains absolutely perfect. If the test is not to include the installations of consumers, it is absolutely impracticable to carry it out, since it would involve the disconnection of each consumer from the mains. In the case of large stations with, say, 1,000 consumers connected, there would not be time to test them, and the public inconvenience caused would preclude the use of the light.

Northern Society of Electrical Engineers.—Leave out all after "such circuit" in lines 3-4 of first paragraph down to "shall" in line 1 of second paragraph. In place of "at least once in every week" insert "from time to time." Omit last paragraph commencing "Provided" and ending with "exists."

Mr. H. M. Sayers, in moving the Bournemouth amendment, emphasised the difficulty of distinguishing between the capacity current and leakage current when alternating currents were employed.

Prof. Ayrton pointed out that this difficulty did not exist, as the difference in phase between these two currents provided a ready means of determining their respective values by the aid of a wattmeter.

Mr. Barker, of Cambridge, said that the test could not be applied where a large number of transformers—say, 150—would have to be disconnected from the system.

Mr. Crompton stated that he considered this obligation to test the mains once a week unnecessarily severe, and moved that words "from time to time," or "at frequent intervals" be inserted. In certain cases daily tests were not too frequent, but, on the other hand, sometimes a test once in three months was ample.

Major Cardew said that the idea of the Board of Trade was to encourage some continuous system of testing, and recording the insulation of the system with respect to earth.

Mr. Crompton said that the insulation at successive instants varied enormously, as certain bad circuits were switched on, which thus prevented the continuous test from indicating the condition of the mains.

The **Chairman** said they wished the test to include the leakage on the consumer's premises.

Mr. Crompton said it would be impossible to localise the fault without detaching the house circuit. A company had to take great precautions when sending their men into houses, and great objections would be raised to frequent visits.

Prof. Kennedy thought a company should not be responsible for anything beyond their own mains.

Major Cardew said the supplying company must be looked to to see that the insulation was maintained on the consumer's premises, as the company was empowered to disconnect when there was a bad leak on the wiring, and they were also empowered not to connect if they considered the work on the consumer's premises was unsatisfactory. In the case of a bad fault they could cut the consumer out at once, and the Board therefore left it to them to keep the insulation of the whole circuit up to a reasonable amount. He thought experience showed that there would not be many very bad cases.

The **Town Clerk of Bournemouth** said he was directed to ask the Board to take reasonable precautions for the public safety.

Mr. Gay, of Islington, said he had known cases where contractors had refused to make alterations required on the ground that they were within the limit the Board of Trade prescribed as a minimum.

The meeting adjourned for half an hour, and on resuming the **Chairman** said he would accept the suggestion that "once a week" should be omitted. At present he had no definite amendment before him.

Major-General Webber said the word circuit, which was a telegraphic one, should be defined.

Dr. John Hopkinson suggested one two-hundreth part of the maximum current should be the limit, but he would be content with such a limit as would bring them into agreement with Clause 45.

Mr. Morse observed that the undertakers had no power to enter private houses except they contained apparatus which was the undertaker's property.

The **Chairman** said it would not be necessary.

Prof. Kennedy said he had found it to be necessary in some cases.

Major Cardew said the test should be applied to the parts of the wires in the house belonging to the undertakers.

Prof. Kennedy: You must disconnect yourselves.

Major Cardew: Yes.

Prof. Kennedy then referred to the difficulty of disconnecting the supply mains if a vulcanised joint was used.

Major-General Webber proposed an amendment that the test should be such a one as was approved by the Board of Trade, as this would allow for the difference of systems in use.

Lord Russell concurred, as it was not desirable that too low a test should be adopted generally in order to cover the needs of some special system.

Mr. Gunnion, who appeared with Lord Russell for the London County Council, thought it would be only putting off the evil day, since each company would be left to fight with the Board of Trade as to what were the particular requirements of its system. They must not omit to take care of the public safety through a desire not to be hard on a particular company. If one wanted one safeguard removed, and another another safeguard, by the time all were satisfied they would be left without any safeguards at all.

Mr. Preece said the clause was a most important one. There was not a single electrical enterprise that had not been kept in order by some such means as were desired by the clause. Major-General Webber had suggested that the clause was liable to be misconstrued, and that it did not include the lamps and apparatus in houses. In his (Mr. Preece's) mind it included everything. Serious trouble had arisen from the way in which cheap work was put into houses, and also from the fact that the maintenance of the work was often neglected entirely. On the other point, that once a week was too frequent, he thought that there was nowhere a much larger electric system to be kept in order than the telegraphic and telephonic system of the Post Office of this country, and the practice there was to test all the circuits every morning. It was done with the greatest ease, and gave them the earliest possible notice of any faults. He could not imagine that any electrical enterprise could find any real difficulty in securing a test once a week. As a practical man, he would urge that the clause should be maintained. The test of one one-thousandth part was not a large one. It might be necessary to make a reduction in some cases, but that should be the exception and not the rule.

The **Chairman** said he could not announce any decision on the subject that day. The **Chairman** said that There was an obvious misprint in the next two clauses. The last sentence in Clause 12, commencing with "If this protection . . . ," should come at the end of Clause 11.

(11) All material used for insulating electric lines or apparatus shall be of the best quality, and thoroughly durable and efficient, having regard to the conditions of its use. Suitable provision shall be made for the protection of the insulating material against injury or removal.

Burton-on-Trent Corporation.—Submit that last sentence of Regulation 12 should be transposed to this regulation.

Notting Hill Co.—Regulation too severe.

Institution of Electrical Engineers.—Transpose last sentence of Regulation 12 to end of this regulation; but alter the sentence by inserting the words "except in the case of low-pressure lines" before "be efficiently."

London Chamber of Commerce and Charing Cross and Strand Co.—Add last sentence of Regulation 12 at end of this regulation.

Westminster Co., Edinburgh Corporation, Aberdeen Corporation, Belfast Corporation, Oldham Corporation, and Sunderland Corporation.—"This protection" appears to refer to insulating material, which obviously cannot be intended.

(12) Every high-pressure conductor shall be continuously covered with insulating material to a thickness of not less than one-tenth part of an inch, and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulating material shall not be less in inches or parts of an inch than the number obtained by dividing the number expressing the volts by 20,000. If this protection be wholly or partly metallic, it shall be efficiently connected with earth.

Bournemouth Supply Co.—Point out omission of words after "20,000" relating to "protection" as distinguished from "insulating material."

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British Insulated Wire Co.—A provision should be inserted making it compulsory that the metallic protection shall be continuous throughout its length, and should be put to earth at one spot only.

London County Council—Some words have evidently been dropped out in the last line but two.

Burton-on-Trent Corporation—If regulation will apply to existing high-pressure wires, Corporation will have to remove all their high-pressure conductors (which are $^{7}/_{16}$'s) and all the electric lines between them and the transformers Suggest that clause should not apply to existing high-pressure conductors belonging to works already provided. Can specify minimum insulation of one-tenth of an inch for all future extensions. Submit that last sentence of clause should be struck out and added to Clause (11).

Yorkshire House-to-House Co.—Minimum thickness of one-tenth of an inch of insulating material is in the case of small cables unnecessary, and that the quality of the insulating material should be taken into account as well as the thickness. Are advised that for smaller sizes (up to $^{7}/_{14}$) one-tenth of an inch is too great a thickness, but that the thickness should vary in proportion to the size of the cable. Their cable in use has a guaranteed minimum insulation of not less than 5,000 megohms per mile at 60deg. F.; suggest that a test of this character would be of greater value than mere thickness of material without regard to quality.

Wolverhampton Corporation.—Is this intended to apply to armoured concentric cable?

London Chamber of Commerce—For the smaller size of cable one-tenth of inch insulating material is too great a thickness. Thickness should vary with the size of cable.

Manchester Corporation.—Omit entirely. If the clause is enforced, nearly the whole of their existing feeders will have to be relaid.

Eastbourne Co.—Minimum insulation resistance specified is excessive for small conductors. A large proportion of company's cable has a less thickness of dielectric, but it is of the best quality vulcanised rubber, and is further protected with insulating tape, etc.

Institution of Electrical Engineers.—See observations on Regulation 11.

Clauses 11 and 12 were taken together. It was suggested that if the limit of pressure were not raised the Manchester bare copper mains would come under the regulation, hence their motion to omit the clause, and the **Town Clerk of Hull** said the same thing applied to their case. With the good system of ventilation adopted, bare copper had been used at Hull with perfect success for three years.

Mr. Crompton said that he could see no object to be gained in earthing a protecting metallic shield with the direct-current low-tension system.

Major Cardew said it was most undesirable to have a conductor in a conduit which was insulated and not connected to earth. Not being a part of the circuit, its potential was indeterminable.

Mr. Crompton protested against this. It was simply an experiment.

Lord Russell supported the regulation.

Mr. Urquhart said if it was an experiment it was one that had been tried for a considerable period with success at Richmond, where the metallic protection of the cables was connected to the iron culverts.

Mr. Hammond, on behalf of the Yorkshire House-to-House Company, urged that the regulation should not be retrospective. They had many conductors laid which would not conform to the minimum thickness clause and yet would give over 5,000 megohms per mile.

Prof. Kennedy remarked that this was one of the clauses affected by what would be the decision as to raising the limit for low pressure. It would decide whether Belfast, Edinburgh, Richmond, Glasgow, Dundee, and Oldham came under the regulation.

Mr. H. W. Wilkinson, of Eastbourne, said they had some bare copper mains there which had given no trouble over a period of 13 years, and which they did not want to relay.

The **Chairman** said he proposed to advise the Board that the regulation should be prospective only, but with this condition—namely, that if any evil effects were discovered from the want of conformity to this regulation, the company concerned would then have the regulation made applicable retrospectively.

(13) No electric line, machine, device, or apparatus intended to form part of, or be connected with, a high-pressure circuit shall be brought into use unless the insulation thereof has withstood the continuous application during one hour of twice the pressure to which it is intended to be subjected in use. The undertakers shall duly record the results of such test.

Bournemouth Co.—Qy. If this is to be applied to the outer insulation of a concentric cable what fraction of the working pressure between the two conductors is to be taken as the working pressure between the outer conductor and the earth. Point out that the outer conductor under normal conditions takes very nearly earth potential, but under occasional accidental circumstances may be exposed to the full working pressure.

Bolton Corporation.—If the regulation is retrospective, it would cause great inconvenience, and possibly breakdown, to test all their existing high-pressure plant with 4,000 volts for one hour.

Dublin Corporation.—The regulation will be difficult to enforce. Corporation test cables and transformers to 50 per cent., and doubt advisability of exceeding this. Think that it would not be safe to test generating plant at double working pressure.

House-to-House Electric Light Co.—Consider it would be running a great risk to double the voltage required in some instances, such as alternators.

London County Council.—The test to be applied should be made by some method and under conditions approved by the Board of Trade; or, alternatively, further definition should be inserted.

Burton-on-Trent Corporation.—Suggest elimination of clause as unnecessary. Their machines, etc., have not been tested to twice working pressure, and they would be put to considerable expense in providing special "step-up" transformers and other appliances for conducting the test

Wolverhampton Corporation.—Much too rigorous. Application of a test pressure or 50 per cent. above working pressure is ample.

Islington Vestry.—Object to include word "machine." Do not think it would be judicious to subject any alternator or dynamo to twice the working pressure.

Taunton Corporation.—Regulation should be relaxed in stringency; it is unnecessarily severe Their adviser suggests that all concentric cables intended for use with high-tension current should be tested with double the working pressure for one quarter of an hour, applied between the inner and outer conductor, and a pressure equal to the working pressure between the outer and earth, and that all alternators and transformers should be tested for half an hour with a pressure 50 per cent. greater than the working pressure.

London Chamber of Commerce.—The words "machine, device, or apparatus" in line 1 should be omitted.

Chelsea Co.—The provisions of this clause would be detrimental to the plant. If at all necessary, the full working pressure applied during 15 minutes should suffice.

Newcastle Co—Impracticable for a representative to see a test and record the result in connection with every piece of machinery supplied. Suggest that the guarantee of the manufacturer as to the testing should satisfy Board of Trade.

Portsmouth Corporation and Shoreditch Vestry.—Suggest subjecting apparatus to twice working pressure for a quarter of an hour, and to a 50 per cent. increase on the working pressure for a further three quarters of an hour.

Westminster Co., Edinburgh Corporation, Aberdeen Corporation, Belfast Corporation, Oldham Corporation, and Sunderland Corporation.—This would compel the testing of every dynamo or alternator for one hour to twice its working pressure: This is undesirable Probably this is not the intention of the clause.

Manchester Corporation.—Omit entirely. It would be very expensive and very troublesome to carry out this test, and quite unnecessary for so low a pressure as 400 volts.

Northern Society of Electrical Engineers.—Alter "twice" to "1½ times."

Institution of Electrical Engineers.—Line 1, omit "machine, device, or apparatus."

On this clause **Prof. Kennedy** asked if the test applied to alternators, as in that case he considered it too stringent.

Major Cardew thought it was too high a test for those machines.

Mr. Gay said it most serious to have a dynamo subjected to a double pressure. It might strain the insulation and cause a breakdown at some future date. He would suggest that 25 per cent. above normal pressure would be a better value to give as the increase.

Mr. Hammond suggested 50 per cent. It might happen in testing an alternator that the engine varied its speed, and cause the E.M.F. to rise to that value.

Mr. Gay asked if it was permissible to use a current from outside for testing, or must the machine be run at the pressure indicated.

Major Cardew said an outside current might be used.

Prof. Ayrton said there were certain cases where for a moment there might be a pressure very much exceeding the working pressure on an alternating system. In putting on a transformer there might be a pressure of 4,000 volts for the fraction of a second. The proposed regulation was therefore desirable.

The **Chairman** asked how a 25 per cent. increase of pressure for a machine and twice the pressure for a cable would meet the wishes of the meeting.

Lord Russell suggested rather a six hours' run at 50 per cent. excess for machines, as being in the interest of the public voltage.

Mr. Hammond said a six hours' run at full load never occurred in practice.

Mr. Crompton, on behalf of the Institution of Electrical Engineers, urged that the Board of Trade were considering the safety of the public, which was not at all concerned, as the machines were all in the generating station. He thought they should avoid grandmotherly legislation.

Lord Russell objected. If a machine broke down and earthed 2,000 volts, he presumed that would affect the mains.

The **Chairman** said there was pressure continually kept upon the Board of Trade to be more grandmotherly than it was.

Prof. Ayrton said the proposal amounted practically to a clause in the specification for the supply of the apparatus.

The **Chairman** asked how Prof. Ayrton got over Lord Russell's argument.

Prof. Ayrton said it was no argument at all.

The **Chairman** said his decision probably would be a test of twice the pressure for an electric line and 50 per cent. in case of a machine.

In this clause, the words "by fire, or explosion, or any accident," were struck out, and "have caused" altered into "cause."

(14) Where any portion of any electric line or any support for an electric line is exposed in such a position as to be liable to injury from lightning, it shall be efficiently protected against such injury.

(15) Where any accident by fire or explosion, or any accident causing or likely to have caused personal injury

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occurs at any part of any electric line or work to which these regulations apply, the undertakers shall give immediate notice thereof to the Board of Trade.

Burnley Corporation.—That the regulation should be revised so as to provide that only accidents causing or likely to cause personal injury should be reported. Suppose Board of Trade do not require to be informed of every trivial accident that occurs at the station or elsewhere.

Lancaster Corporation.—Clause covers every trivial accident Suggest revision so as to provide that only accidents causing or likely to cause personal injury be reported.

Blackburn Corporation.—The wording is too general, and might include any petty mishap.

Wolverhampton Corporation.—Do not think there should be any necessity to report accidents which have caused no serious personal injury.

Institution of Electrical Engineers.—Line 1, after "where any" insert "serious," lines 1 and 2, omit "or any accident."

London Chamber of Commerce.—Line 4, after word "apply" insert "except on the consumer's premises."

Glasgow Corporation.—Clause is vexatious. Only such accidents as have actually caused personal injury, that would necessitate the removal of the injured person from his work for a number of hours, should be reported.

Westminster Co., Edinburgh Corporation, Aberdeen Corporation, Belfast Corporation, Oldham Corporation, and Sunderland Corporation.—Wording of clause is so vague as to be inoperative except in most serious cases. It seems doubtful whether it is desirable that any such reports should be made to the Board of Trade except in serious cases.

Mr. Barnard moved the suggestion of the Lancaster Corporation. The regulation should only apply to serious accidents.

The **Chairman** said he had tried for years to define what was a "serious accident," and had failed.

Mr. Hesketh objected to "likely." A high-tension fuse blowing might cause injury, and were they to report that? He would propose only cases where a man had been injured so as to be kept from his work should be reported.

Mr. Hammond thought it would cause a very large number of reports.

The **Chairman** said in the case of the railways every man who jammed his thumb was reported to the Board.

Mr. F. Bayley asked if the regulation applied to accidents on the consumer's premises.

The **Chairman** said it would not, unless the premises were under the jurisdiction of the undertakers.

Mr. Sayers said they had already to give notice of injuries to workmen under the Accidents to Workmen Act. It should not be necessary to give two notices of the same thing.

Mr. Boveridge (Edinburgh) proposed to alter the wording to "where any accident causing serious personal injury."

The **Chairman** said "no." An explosion might happen to cause no injury and yet be exceedingly serious. The regulation practically repeated what was in the provisional orders, and would stand with the exception of the alterations above.

(To be continued.)

LEGAL INTELLIGENCE.

ELECTRIC LIGHT CLAIMS.

Proof was recently led in the Sheriff Court at Linlithgow in an action at the instance of Messrs. Hunter and Jack, electrical engineers, of Glasgow, against Mr. Henry S Kirsopp, draper, of Bathgate, for payment of £36. 4s. 7d., being the balance of contract price for an electric light installation to the defender's premises in Bathgate. The contract price was £166 6s. 8d. The defender had paid part of this to account, reducing the amount to the sum sued for. Defender contended that the pursuers asked permission to fit up on the outside of his premises two arc lamps for the inauguration of the installation. Defender averred that the lamps did not turn out satisfactory; that in the month of January last one of the brackets from which the lamps were suspended broke, and in its fall smashed one of the defender's shop windows, and injured two women and a child. He attributed the accident to carelessness in fitting up the lamps, and said that the bracket was insufficient to bear the strain of the lamp. Defender also stated that he had paid the persons who were injured £30 in full of their claims for damages, and he held that pursuers were bound to repay him that sum, as well as to allow him certain deductions, and that there were due to him more than the amount sued for. The Sheriff has now issued an interlocutor in which he finds that pursuers having completed the work they are entitled to payment of the sum sued for. The lamps, he says, which were at first fitted up, were changed for two lamps of a different pattern; one was removed and placed in a higher position by the defender without the sanction of the pursuers, and the defender ought either to have left the arc lamp in the position in which it was at first placed or called in the pursuers to remove it.

In the Westminster County Court on Friday the case of Harrison *v.* Estelle was tried before his Honour Judge Lumley Smith, Q.C., and was a claim by the plaintiff, an electrical engineer, to recover a balance of account of 15 guineas in respect of electrical work done to the order of the defendant.

It appeared from the opening statement of counsel that the plaintiff had done work to the extent of over £100, the greater portion of which had been duly paid for, but the defendant appeared to have adopted the opinion that the work now claimed for was in respect of alterations which had been rendered necessary owing to the plaintiff's own mistake in the fixing.

The **Plaintiff** was called and gave detailed evidence as to the items which were the subject of this action, and absolutely denied that the work was rendered necessary owing to his own mistake.

The **Defendant** was called and said that in several respects the work was not carried out according to her orders, and consequently she had to request the plaintiff to make some alterations, but she never expected to have to pay extra for that.

His **Honour**, having gone through the whole of the items at some length, said he thought the defendant was right as to some of them, therefore he should reduce the plaintiff's claim by six guineas, and give judgment for nine guineas and costs.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Manchester.—The Corporation invite tenders by 10 a.m. on December 2 for the supply and erection complete of two dynamos at the Foreign Animals Wharf, Mode Wheel. Full particulars are given in our advertisement columns.

Magdeburg.—The State Railways invite tenders by November 26 for the supply of 25,800 kilos of galvanised iron wire and 1,500 porcelain insulators on screw supports. Conditions for 1 mark from and tenders to Die Königl. Eisenbahn-Direction, Magdeburg.

London, S.W.—The Secretary of State for India is prepared to to receive tenders for caissons, air-compressing, and electric light plant. Particulars are to be obtained from the Director-General of Stores, at the India Office, S.W., and tenders must be delivered by December 10.

Leicester.—The Corporation invite tenders for the supply and delivery of the necessary cast-iron pipes and connections, from 2in. to 24in. in diameter, required during 12 months ending December 31, 1896, for the Gas and Electric Lighting Committee. Specification and form of tender to be obtained from Mr. Alfred Colson, M.I.C.E., engineer and manager, Millstone-lane, Leicester. Tenders, addressed to Alderman Lennard, chairman, and endorsed "Tender for Cast-Iron Pipes, etc.," are to be delivered by 11 a.m. on December 7.

Brussels.—The Ministère de la Guerre invitee tenders by January 15 for (1) a heating installation, (2) electric lighting in the new military school to be constructed in the Avenue de la Renaissance, Brussels.—The Administration des Télégraphes requires tenders by December 18 for the supply of various large lots of pine telegraph poles. Special cahier des charges No. 26 at the Brussels Bourse.—The municipal authorities invite tenders by November 26 for the supply of pipes and apparatus in connection with the electricity works. Security 5 per cent. of the amount of the tender. Conditions from L'Hôtel de Ville, Brussels.

Swansea.—The Corporation invite tenders for the following works: Contract No. 1: For the supply and erection of destructor and electricity supply station buildings complete, including engine and destructor houses, offices, approach roads, and yards. Contract No. 2: For the erection of a chimney shaft, 150ft. in height, with all necessary foundations and accessories. Contract No. 3: For the supply and erection of a dust destructor, including eight destructor furnaces, and four water-tube boilers, with all flues, dampers, and accessories necessary to the satisfactory setting to work of the same. Specifications, bills of quantities, and forms of tender of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, S.W., for £3. 3s. each specification. The plans can also be seen at the offices of the engineers or at the Guildhall, Swansea. Sealed tenders are to be sent to Mr. Jno. Thomas, town clerk Guildhall, Swansea, endorsed "Swansea Dust Destructors and Electricity Supply—Tender for Contract No. 1, 2, or 3," as the case may be, at or before 4 p.m. on December 6.

RESULTS OF TENDERS.

Brompton (London).—The following tenders were received for electric light wiring and fittings, for the committee of the Cancer Hospital, Brompton, S.W. Mr. Morgan Williams, A.M.I.C.E., was the consulting engineer:

	Wiring.	Cutting away and making good.	Fittings, exclusive of lamps.
Crompton and Co.	£668 0 0 ...	£45 0 0 ...	£107 8 0
Rashleigh Phipps and Co. ...	523 0 0 ...	20 0 0 ...	115 5 6
H. M. Leaf	330 0 0 ...	25 0 0 ...	99 11 6
Drake and Gorham (accepted).....	309 0 0 ...	25 0 0 ...	86 19 0
Sotheby and Co....	293 10 0 ...	26 10 0 ...	77 14 0

Bursiem.—The tender of Messrs. Crompton and Co., Limited, amounting to £213, has been accepted for supplying and fitting an electric light installation in the baths.

Tongres.—For the electric lighting of Tongres. Tenderers: Compagnie Internationale d'Electricité, Liège, 0·308f. per hour per arc lamp of 8 amperes, and 0·0385f. per hour per 16-c.p. incandescent lamp; Société anonyme d'electricité (Bouckaert et Cie.), Brussels, 0·308f. ditto, and 0·029f. ditto. The Société anonyme

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du phœnix and the Société pour les applications générales de d'electricité (systèmes Siemens et Halske) Brussels, also tendered.

Saltash.—The Town Council have accepted the tender of Mr. T. Martyn for lighting the public lamps by electricity at an annual cost of £2 10s. per lamp, subject to a guarantee for the discharge of the contract.

BUSINESS NOTES.

Aberdeen.—The Town Council propose to municipalise the tramway system. Electric traction is projected.

Cardiff.—A correspondence is taking place in the local Press as to the advisability of introducing electric traction on the tramways in Cardiff.

Woking.—The Urban District Council have resolved that tenders be obtained for lighting St John's Ward by electric light, gas, and oil.

Liverpool.—Prince's-road Calvinistic Methodist Chapel, Liverpool, is said to be the only Welsh chapel in the kingdom fitted with the electric light.

Llanelly.—It is likely that the Llanelly Borough Council will sell their provisional order for lighting the town by electricity to Messrs. J. C. Howell, Limited.

Hammersmith (London).—The Hammersmith Vestry have completed the purchase of a site in Fulham Palace-road, at a cost of £2,200, as a site for an electric lighting station.

City of London Electric Lighting Company, Limited.—A private meeting of this Company was held at Winchester House, E.C., on Monday last, the Press not being admitted.

The Eastern and South African Telegraph Company, Limited, announce the numbers of 5 per cent. mortgage debentures drawn for payment at par on January 1, 1896.

Hospital and Church Lighting.—Messrs. Drake and Gorham have been entrusted with the contracts for the electric lighting of the Cancer Hospital at Brompton and St. Paul's Church, Deptford.

Richmond (Surrey).—The Electric Lighting Committee of the Town Council have reported that the company had made the necessary deposit, and the authorised works were proceeding satisfactorily.

St. James's and Pall Mall Electric Light Company, Limited. We are informed that the recent issue of 4 per cent. debenture stock, offered to the shareholders at 2½ per cent. premium, was largely over-subscribed.

Colwyn Bay.—The District Council have discussed the question of electric *versus* gas lighting, and eventually it was agreed to hold a committee of the whole Council to come to a decision on the subject in a fortnight.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended November 17 amounted to £1,028, as compared with £881 in the corresponding week of last year, being an increase of £147.

British Electric Traction (Pioneer) Company.—The allotment letters for this Company's recent issue of 5,000 shares have been posted. We understand that the applications were largely in excess of the capital required.

Shoreditch (London).—The Shoreditch Vestry are about to enter into negotiations with the trustees of the Christian Institute, Hoxton, which abuts on the site for the electric lighting station, for the purchase of the freehold of the site.

Morecambe.—In the course of a discussion in the District Council on the price of gas, a member said that he did not think the present was an opportune time to see the gas company, because the Council had under consideration the purchase of the electric light works.

"Electricity."—Mr. Sidney Rentell, the proprietor of this popular-priced journal, informs us that owing to the constant increase in its sale, as well as of the technical works published by him he has had to remove to more commodious offices on the first floor of 11, Ludgate-hill, London, E.C.

Plymouth.—Mr. Radford has moved in the Town Council that an electric lighting committee be formed. Hitherto, he said, the question of electric lighting had been left in the hands of a small sub-committee, but so important a matter should be entrusted to a special committee. The motion was carried.

Rochdale.—Councillor R Howarth has asked if the committee appointed some time ago to consider the question of electric lighting had met yet? The Chairman said the committee had met. It was thought possible that they might make some arrangement with Messrs. Platt to get power from their coke ovens.

Newcastle-on-Tyne.—The Corporation intend to apply to Parliament in the ensuing session for leave to bring in a Bill for the improvement of the tramways system now in use. Powers are to be sought to double certain existing lines, which, along with the new lines, are to be worked by "animal, steam, oil, mechanical, cable, or other powers."

Shepshed (Leics.).—The Ratepayers' Association have sent another communication to the Urban Council, in which they recommend the Council to consider the rapid progress the electric light was making before deciding to purchase the gasworks in the present defective state of their mains.

Horseless Car Company, Limited.—This Company has been registered, with a capital of £5,000 in £1 shares. Object: to acquire any patents and inventions relating to motors or motor carriages, and to develop and turn to account the same, and to act as engineers and machinists generally. Registered office, Trafalgar-buildings, Northumberland-avenue, W.C.

Birmingham.—The first meeting of the Nechells Overhead Electric Traction Committee has been held at the Lister Hotel, Great Lister-street; Mr. Newton presiding. It was resolved to write to the Central Tramways Company for information as to the proposed system, and the honorary secretary was instructed to submit their reply to the next meeting of the committee.

Edinburgh.—In view of the Chrysanthemum Show, Waverley Market has been fitted with the electric light. The contractors for the wiring of the market were Messrs Milne and Sons, and the Corporation supplied the lamps. The cost of the installation is between £600 and £700. The Town Council have agreed to extend the electric lighting from the Post Office to Regent's-terrace.

City and South London Railway.—The returns for the week ended November 17 were £958, compared with £972 for the corresponding period of 1894, being a decrease of £14. The total receipts for the half-year 1895 are £17,616, compared with £17,691 for the corresponding period of 1894, being a decrease of £75. The line was partly closed last Sunday for alterations at King William street Station.

York.—At a meeting of the Streets and Buildings Committee of the City Council, Mr. Alderman Agar was elected chairman for the coming year A letter was read from Prof. Kennedy, stating the terms on which he would act as adviser to the committee in regard to the question of electric lighting for the city, and it was decided to employ Prof. Kennedy, subject to the settlement of certain matters of detail with him.

Electric Heating and Cooking.—We have received a copy of the new edition of the illustrated price list of the electrical heating and cooking apparatus manufactured by Messrs. Crompton and Co., Limited, of 35, Queen Victoria-street, London, E C., and Chelmsford. Messrs. Crompton are said to be the only company in the world who have received five diplomas and four gold medals (including Antwerp, 1894) for cooking and heating by electricity.

Belfast.—In addition to the other improvements which the directors of the Belfast Banking Company, Limited, have recently effected in their principal establishment in Waring-street, they have now introduced the electric light. The satisfactory character of the installation is extremely creditable to Mr. J. H. Greenhill, by whom it has been carried out. The illumination is supplied by four arc lamps of 3 000 c.p. each and 92 16-c.p incandescent lamps.

Dover.—Councillor G. Fry has moved that steps be taken to apply for a provisional order for the construction of tramways in Dover without binding themselves to any particular kind of motor. He proposed that the order should enumerate a large number of streets, so that if they desired they should be able to approach the pier, Buckland, and the Folkestone-road by several alternatives, and also Liverpool-street. The motion was adopted by the Town Council.

Brisbane Tramways Company, Limited.—This Company has been registered with a capital of £200,000 in £5 shares. Object: to adopt and carry into effect an agreement expressed to be made between the Metropolitan Tramway and Investment Company, Limited, of the one part, and this Company of the other part; to construct, project, hire, purchase, take, on lease or otherwise, equip, work, and extend, maintain and use tramways and light railways.

Derby.—The Chairman of the Electric Lighting Committee (Mr. Alderman Leech), in presenting the committee's report, has declared that there was no loss on the light, but a slight profit, and that the prospects of the business are exceedingly good. Mr. Leech proceeded to attack another member (Mr. Hart) for making a statement to the effect that a large sum of money had been needlessly spent. This statement, Mr. Leech declared, was quite incorrect.

Eccles (Manchester).—The Town Council have been called upon to consider "the deferred proceedings of the Town Hall, Tramways, and Electric Lighting Committee of September 23 and October 1, and if deemed advisable to order that the corporate seal be affixed to a contract with respect to electric lighting works, and to authorise application to the Local Government Board for borrowing powers." The further consideration of the subject was again postponed.

Godalming.—The Town Council have passed the following resolution: "That the Town Council of the borough of Godalming, acting as the urban sanitary authority, do apply to the Board of Trade, under the provisions of the Electric Lighting Acts, 1882 and 1888 for a provisional order authorising such authority to supply the electric light for public and private purposes within the area of the said borough, and also within certain parts of the parish of Godalming Rural."

The Telephone in Java.—The Intercommunal Telephoon Maatschappy is the name of a company which has lately been formed at Batavia, Java, with a capital of 500,000fl., to acquire and work concessions which have been granted for the establishment of telephonic communication between Batavia, Semarang, and Soerabaya, and between Batavia, Cheribon, Tegal, Pekalongan, and Semarang. A domand has further been made for a concession to erect and operate a telephone exchange in the town of Macassar, in the island of Celebes.

Forthcoming Bills.—The parliamentary advertisements have been made for Bills to be introduced next session by the Edinburgh Corporation for making, acquiring, working, or leasing tramways;

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by the Corporation of Cork to produce, store, and supply electricity in the city of Cork; by a company to construct an electrical tramway from Derby to Ashbourne, with running powers over a portions of the lines of the Derby Tramways Company, Limited; and by a company to construct an electric tramway (3ft. 6in. gauge) from Kidderminster to Stourport.

Fareham (Hants).—A committee meeting of the whole of the members of the Urban District Council has been held to receive a deputation from a meeting held some time since, with a view to effecting a compromise of the action for non-fulfilment of contract for the purchase of the undertaking of the Fareham Electric Lighting Company. The views of the deputation as to an amicable settlement were lucidly explained, but they were not endorsed, it being decided to continue the action, the hearing of which is expected to take place within the next week.

Sheffield.—A body of British capitalists and tramway experts, called the London and Provincial Tramway Company Syndicate, are about to deposit a Bill in Parliament seeking powers to construct a complete network of electrical tramways in Sheffield. Their object is to take over from the Corporation of Sheffield all the lines of the existing system, to purchase from the company their freeholds and rolling-stock, and to provide a rapid regular, and prompt tram service which will bring all the districts within easy reach of one another. The overhead system is proposed.

Cowes.—A member of the District Council has submitted a proposition to the effect that the Cowes Gas Company should be asked for the lowest terms on which they would light the town with incandescent lamps. He urged that they should try to make some arrangement with the company before the Council went for the provisional order to use electricity. A long discussion ensued, in the course of which it was pointed out that the provisional order did not necessarily mean that the Council would themselves institute the electric light. The motion was lost, two only voting for it.

Bangor (Antrim).—At the last meeting of the Bangor Town Commissioners Mr. Bowman asked what steps had been taken by the Board relative to his motion regarding the electric light The Chairman said they had applied for the license The Clerk (Mr. Pollock) said that application had not yet been made Mr. Bowman said it seemed that it was necessary before applying for the license to give a month's notice, and that a special meeting should be called for the purpose It was decided to make the application in a formal manner by bringing it before a special meeting.

Miscellaneous Lighting.—Mr. George du Maurier has recently placed the electric lighting of his house in the Hyde Park district in the hands of Messrs. Rashleigh Phipps and Co, of 102 Oxford-street, W. This firm has also just completed the lighting of St John's Church, Paddington, where 200 lights have been installed. Messrs. Treloar's and Messrs. Hudson Bros.' central depôts in Ludgate-hill have just been lighted by this firm as also the Artists Volunteers' Headquarters, and they have carried out a large extension of the lighting of the St. James's Theatre, for Mr. George Alexander.

Halifax.—A scheme for laying down and working electric tramways in the Halifax district is about to be put forward by a syndicate of gentlemen interested in similar undertakings. Messrs. Land and Foster are the solicitors, and the preparation of the plans is in the hands of Messrs. Utley and Gray, surveyors and architects The line would extend from the bottom of Horton-street, *viâ* Wards End and Commercial-street, to Hall End, and thence by way of Silver-street and King Cross-street to King Cross and Sowerby Bridge Loop lines would probably be made to North Bridge, Highroad Well, and Salterhebble.

Neston (Cheshire).—A meeting of ratepayers of Neston and Parkgate has been held to consider the lighting of the district by electricity. Colonel Lloyd, who presided, said though they spent a 3d rate on gas, the district was not as well lighted as they would like to see it Mr. Grenfell described the economy of electricity, and said the report read at the last Council meeting was very encouraging, and whenever a municipality had undertaken the new departure it had been profitable in reducing the rates The expert he engaged said Neston could save by electricity £700 a year, and this would put the roads in order. Another meeting is to be called.

Nottingham.—A correspondent writes: "A novelty in the lighting of 'buses is about to be introduced into Nottingham by Mann's Nottingham Horse and Carriage Company, Limited, who are contemplating using electricity both inside and outside their 'buses. They have already built, for use to and from Bridgford, a model 'bus, which is fitted with the new lamps, and the vehicle has been very much admired. The lamps are fed from a battery under the driver's seat, and are capable of giving light for 36 hours The arrangements for charging the batteries being satisfactorily concluded with the Corporation, the lamps will be fitted in all the 'buses on the company's route."

Llandudno.—The engineer to the Llandudno District Council has presented a report on the question of providing Craigydon with telephonic communication in case of fire, and the superintendent of the fire brigade, in his report, recommended that telephonic calls should be fixed in the house of each fireman. The engineer was directed to write to four electrical engineers, asking for their terms for advising and reporting generally upon the whole question of the electric lighting of the town. Two applications had been received by the Works Committee for permission to lay down an electric tramway, but as a further application would shortly be received it was decided to leave the question in abeyance.

Douglas.—An arrangement has been entered into between the directors of the Derby Castle Company, Limited, and the directors of the Douglas Tramways Company for the sale of that portion of the Castle property the front line of which extends from the entrance-gates to the ornamental fountain just beyond the lodge. The price agreed upon exceeds £8 000. The property will be utilised by the tramways company for the building of the sheds necessary for the housing of their stock now that the present terminus buildings are to come down, and also for a handsome new station building, which will at once serve for both the Bay tramway and the Laxey electric tramway.

Windsor.—The Town Council have adopted the following report of the Electric Lighting Committee: "(1) A letter has been submitted to your committee from the Thames Conservancy stating that they cannot entertain the proposal to utilise the water power at Windsor Weir for the purposes of electrical energy. (2) Your committee report that they have given directions for an advertisement to be published asking for tenders for taking over the order for electric lighting, and recommend that if it shall appear that the piece of land in the Goswell's belonging to you is the most suitable site, that you sanction the use of a portion of that site for the purpose. Tenders are invited to come in by January 1, 1896."

Kidderminster.—The scheme for connecting Kidderminster and Stourport by an electric tramway is now taking definite shape, and notices have been given of an intended application to Parliament to incorporate a company for making such tramway. It is proposed that it should commence opposite the Town Hall buildings, Kidderminster, passing along Oxford-street, Bridge-street, and New-road, to Stourport, terminating at a point opposite the Bridge Inn, in Bridge-street, Stourport. A second line would commence at the intersection of Spirit-lane and Comberton-road, and connect in Oxford street with the line to Stourport. A third tramway is proposed, running westward of the line in the New-road. Messrs Ivens and Morton are the solicitors to the Bill.

The Archbutt-Deeley Water Purifying and Softening Process Practical and satisfactory demonstrations of this process were given the other day at Smedley, near Manchester, and Adlington, near Chorley. Two tanks, placed side by side, are generally used, the processes of filling, adding the chemicals (lime, alkali, and aluminoferric), and allowing the precipitate to settle being carried on in one, whilst the softened and clarified water is being drawn off from the other. Messrs Mather and Platt, of Salford, the manufacturers of the plant, state that it is at the present time being used, either for water softening or for effluent purifying purposes, by some 20 or 30 firms. The method is fully described and illustrated in the *Contract Journal* of November 20.

Allgemeine Elektrizitats-Gesellschaft, Berlin.—The report for 1894-95 of this Company is an elaborate document, and clearly demonstrates the prosperity of the concern. The number of employés has increased in the financial year from 3.385 to 5,121. The output has correspondingly developed, and 2.049 dynamos and electric motors, with a total capacity of 22,800,000 watts (about 30,000 h.p.), were turned out. Like stabilite, the new mikanite has met with ready acceptance as a high-pressure insulating material. The business profits amount to 4 035,867 marks, against, in 1893-94, 3,205,981 marks, being an increase of 829,886 marks. A dividend of 11 per cent. is proposed, which will absorb 2,200,000 marks; 110,000 marks are distributed as bonuses to the employés and donations to the provident fund; and 67,318 marks are carried forward. Prospects continue good.

Bangor (N.W.)—The electric lighting question continues to be discussed with unabated vehemence in Bangor. At the last City Council meeting Dr. Rowland Jones, in pursuance of notice of motion, proposed the following resolution: "That the resolutions passed at special meetings of the Council held on August 30, October 9 and 25, 1895, to carry out a scheme of electric light next year, to apply to the Board of Trade for a license, etc., and instructing Mr. Medhurst to proceed with the plans at once, etc., respectively, be rescinded, and that, in accordance with the tenour and terms of the resolution passed by the Electric Lighting Committee on September 20 last, and confirmed by the Council on October 9 next following, the Council do now apply to the Board of Trade for a provisional order only." After a long debate Dr. Rowland Jones's resolution was declared lost by 13 votes to 8.

Telephones in the West Riding.—The Duke of Norfolk has received a deputation from the West Riding on the subject of increased facilities for telephonic communication being granted to Yorkshire. The Duke of Norfolk eventually said there were two points to be considered—one the unification of the area in question, and the other the increase of the trunk wires. As to the first point made if acceded to it would upset a scheme maturely considered, and he would only be misleading them if he held out any hope of being able to do that. The areas were all specified and had been drawn up carefully, and the deputation asked that they should all be thrown into one. This could not be done. As to the second point, about the increase of trunk wires, they were anxious to do all they could in that direction to meet their wishes. Perhaps they would like to send in writing any suggestions as to special cases

Ashton-under-Lyne.—Councillor Kelsall said, at the last Town Council meeting, that they ought to appoint an electric lighting committee Previous committees had to all intents and purposes been stillborn. If they had a committee, they would not have the semi-scandal of retaining powers for carrying out the electric lighting scheme and doing nothing to accomplish the purpose. Tradesmen were complaining and people were putting in private installations. He moved that a committee be appointed, and Councillor Phillips

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seconded. The Town Clerk said it would be necessary, in appointing a new committee, to adopt instructions to it. Would it not be better to consider the matter in General Purposes Committee? The town clerk's suggestion was agreed to A number of formal resolution were then passed with regard to the application to the Local Government Board mentioned in the minutes of the General Purposes Committee.

Appointment Vacant.—The Governors of the Belfast District Lunatic Asylum will on December 9 appoint an engineer for Purdysburn auxiliary. Candidates must be over 20 and under 35 years of age, and the person selected will be required to devote all his time to the asylum service. He must be able to take charge of steam-engine and boilers and the electric lighting plant, and have previous experience in running private plant with batteries, and be able to do his own repairs. Applications with copies of testimonials respecting character and efficiency, and certified copy of registry of baptism, should be sent in by noon on December 7. Salary £65 per annum, with rations, residence, clothing, fuel, light, and washing.—The Lighting Committee of the Wolverhampton Corporation require a clerk and canvasser in the office of the borough electrical engineer. Particulars will be found in our advertisement columns.

Norwich.—A petition on behalf of the Property Owners' Association has been presented to the Norwich Town Council protesting against the exorbitant prices charged by the British Gaslight Company for gas, both for private and public consumption, and asking further that the Council should take steps for opposing the Bill of the company now before Parliament. A member thought the matter was of grave importance, and he moved that the memorial be referred to the Law Committee, with a request from the Council to take the most energetic steps in their power with a view to preventing the gas company extending their monopoly, and for the Council to avail itself of the opportunity to appear before the House of Commons, so that the citizens may obtain relief from the present exorbitant charges of the company for gas, etc. This was agreed to. Why does not Norwich try electricity?

Kettering.—A special meeting of the Urban Council has been called for the purpose of considering the expediency of applying for a provisional order authorising the Council to put down electric lighting plant in the town. The clerk read the minutes of the proceedings of the Electric Lighting Committee, which was a general decision to recommend the Council to apply forthwith to the Board of Trade for the necessary permission to supply electricity within a given area. The report of the committee was moved by Mr. F. Mobbs, who stated that the committee had gone carefully into the matter, and had been considering a list of 110 towns where the electric light was in vogue, and 112 others where it was contemplated. Personally, he was not in favour of the work starting at once, and if they obtained the order they would not be called upon to proceed with the work for two years. The motion was eventually carried.

Gloucester.—The town clerk has informed the City Council that in June last notice was received from Mr. Walter Webb, on behalf of the Great Western Light and Power Company, giving formal notice of their intention to apply to the Board of Trade for a provisional order authorising the supply of electricity for public and private purposes within the city. It had been resolved at a meeting of the Finance and Streets Committee to recommend the Council not to consent to the proposed application of the company but for the Council to apply for the provisional order themselves. The Mayor now moved that the Council should not consent to the application of the Great Western Electric Light and Power Company, and the motion was carried, as also a resolution that application be made to the Board of Trade for a provisional order under the Electric Lighting Acts of 1882 and 1888, to supply electricity for public and private purposes in the city.

Hampstead (London).—The Lighting Committee of Hampstead Vestry have reported that they had given instructions to the chief engineer to make a periodical report to them as to the loss of electric current in transmission, but were of opinion that such reports should not be presented to the Vestry, as no advantage could possibly arise by making them public. It was referred to the Lighting Committee to consider the advisability of extending the lighting cables from Heath-street to The Grove. Mr. Reed explained that by doing this now, when the cable was being laid in Heath-street, a considerable saving would be effected. The surveyor stated that his department and the Lighting Department work in conjunction when the cables are laid, so as to avoid unnecessary expense. Mr. Dainton complained that since the current had been switched on to the cables in West-End-lane his telephone had been rendered almost useless. There was a constant buzzing sound, which was due, he was told, to the electric lighting current. The engineer said that he had examined the telephone and found a constant buzzing. Telephones were greatly affected by the weather.

Bolton (Lancs.).—The *Bolton Journal* is publishing a series of articles entitled, "Shall Bolton Have Electric Trams?" The writer remarks that this is a question which will, without doubt, occupy the attention of the Corporation in the very near future A few months ago a sub-committee was appointed, consisting of equal numbers of the Street and Gas and Electricity Committees, to obtain information on the subject, and for the purpose, if necessary, of breaking down any prejudice which might exist in the minds of the public against the employment of electricity as a motive power in thoroughfares. The throes of a general election into which the country was plunged, followed by the local municipal contests, interfered with the active prosecution of enquiries into the subject; but the newly-constituted Corporation will now, in all probability, renew the consideration of the question as to the advisability of employing electricity instead of horse power in connection with the tramcars. By a clause in the agreement with Messrs. Holden, the lessees of the tramlines, electricity can be employed at any time should it be considered by the Corporation to be cheaper and more advisable than horse power.

Whitehaven.—Councillor Musgrave, in proposing the confirmation of the Water and Lighting Committee's minutes, said, with regard to the proposed extension of the electric light station, that he was very glad to say that their electric lighting had become so popular, and had been so much appreciated by the consumers, that they were getting a very satisfactory revenue from that source, and the probability of a very considerable increase in private consumption was so patent to the committee that they considered they should be looking round with a view to acquiring additional property to meet future demands. There was no immediate necessity for extension, but thought the time could not be far distant when some extension would require to be made Within the next few months the Council would be asked to sanction an application to the Local Government Board for further borrowing powers connected with the electric light.

Radcliffe (Lancs.).—Mr. Cunliffe, in accordance with notice of motion, has moved, "That this District Council, having obtained a provisional order for generating and supplying electricity for lighting and other purposes, take into consideration the advisability of putting this power into operation." He believed that Radcliffe of all places, ought to be lighted with electricity. The fact that they received a provisional order without opposition was favourable evidence as to the necessity of electricity in Radcliffe. The late Local Board went into the question of cost, and estimated that it would not cost more than £10,000, and he thought they might make an investment of £8,000. At the present time there were 603 lamps in the streets of Radcliffe and Stand-lane. The Council paid the gas company £389. 15s. 3d. for gas last year, and £171. 7s. 2d. were spent in wages to lamplighters, etc. That was a large sum, and a considerable amount of it might be saved if they had electricity. There were 35 localities in England where plants had been laid down, and £4,500,000 had been sunk. There were 25 towns where contracts had been let out for works, at a cost of £870,000, and 22 towns had obtained statutory orders for spending £822,000 The resolution was agreed to.

The New Electric Railways in London.—The City Commission of Sewers have had under consideration an application by the Central London and Waterloo and City Railway Companies to make certain modifications in the design of subways in connection with the central station to be constructed at the Mansion House. The modifications now suggested by Sir Benjamin Baker and the other engineers are principally to avoid interference with adjacent buildings One of the alterations is to connect the platforms of the Waterloo and City Railway by inclined subways with the system of foot-passenger subways to be formed in front of the Mansion House. Another modification has reference to the proposed staircase at the corner of Princes-street. Owing to the vaults of the Union Bank projecting further beneath the public way than was originally allowed for, the company desire to alter the plan of the staircase in such a way as to involve a further absorption of the carriageway. The Commission consider this alteration highly objectionable, and have refused their sanction to it In regard to the whole scheme, the Commission, before giving permission to commence any of the works, are requiring the Central London Railway Company to satisfy them as to their ability in every respect to complete the station, subways, and approaches in conformity with their Act. Communications between the Commission and the company on that subject are now being conducted with every probability of a satisfactory result.

Cambridge.—The Commons Committee of the Town Council have reported: "That they have received an application from the Cambridge Electric Supply Company, Limited, for permission to erect poles to carry an air line across Laundress Green and Sheep's Green to enable them to supply current to the skating ground in Grantchester Meadows. Your committee recommend that the request of the company be acceded to upon condition that a payment be made of 1s. per pole, that the poles to be so constructed as to prevent boys from climbing them and so coming in contact with the air line and that they be removed at the end of the season." Alderman Redfern moved, and Councillor Rae seconded, the adoption of this report. Councillor W. F. Taylor said that he had no wish whatever to stand in the way of the success of the electric light company, or of persons who wished to see the light; but he certainly thought on those open commons lads might by chance climb the poles and pull them down if they were only of a temporary character, and cause the death of several persons. It was a very serious question, and he could not understand why it had been taken away from the Paving and Drainage Committee to the Commons Committee. Alderman Dr Porter suggested that the proper course would be to invite the opinion of Prof. Ewing as to the advisability of carrying a wire of that kind across the two commons. He understood that it would be an extremely dangerous thing, and he thought the opinion of an expert ought to be taken. It was ultimately decided to refer the matter back to committee.

Bowness.—The clerk has laid the electric lighting agreement before the Urban Council. Mr. Garnett said he wished to draw attention to a nuisance in the telephone system by a buzzing noise which was caused by the electric light system when the current was turned on at nights He believed the nuisance could be stopped; it had been cured in London. Mr. Logan said they had nothing to do with it. The Chairman said with reference to the agreement they had had the opinion of an expert on it, and he

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would therefore propose that it be accepted for the ensuing two years. The £120 which it had been agreed should be paid by the Council if the lighting were satisfactory, had not been paid, and it was proposed that it should not be paid for a period of six months, when the lighting should have worked to the satisfaction of the surveyor. The date of the commencement of the six months would be at the option of the firm, but he (the Chairman) understood that they were now in a position to work the lighting efficiently. But if the Council paid the money and the lighting did not work so well as during the period named, the firm should then refund the £120. The other main points of the agreement were that a payment of £1. 5s per lamp should be made for 1,000 hours light, and if more were burnt the Council should pay more, and if less then less should be paid. Messrs. Fell would also repay the Council £20 towards the salary of an inspector. The Council would also impose a fine, when the light was not burning, of 1d. per lamp per hour, as in London, in addition to making no payment That was a considerable item, as for the last month the Council would receive 38s. 3d. as fines. The agreement was then ratified

Monmouth.—The Town Council have received the following letter from the Local Government Board: "Local Government Board, Whitehall, S.W., November 11, 1895. Sir,—I am directed by the Local Government Board to advert to your letter of the 3rd ultimo, and to state that they have had under further consideration the application of the Town Council of Monmouth for sanction to borrow £20,000 for the purposes of their scheme of sewerage, sewage disposal, and electric lighting. On a careful review of the facts, it appears to the Board to be very doubtful whether the expectations which they understood that the Town Council have as to the advantages likely to result from the adoption of the scheme of electric lighting will be realised; but if, on further consideration of the matter, the Town Council are of opinion that the scheme which has been submitted should be carried out, the Board will not refuse their sanction to the loan. I am accordingly to request that the scheme may receive the further consideration of the Town Council, and that the Board may be informed of the decision arrived at. A copy of any resolution which the Town Council may pass in regard to the question should be forwarded to the Board. I am to add that before sanctioning the borrowing of money for works of electric lighting, the Board will require that the Town Council should obtain the approval in writing of the Board of Trade to the system proposed to be adopted for the supply of electrical energy, in compliance with Article VI. (1) of the Monmouth Electric Lighting Order, 1894.—I am, Sir, your obedient servant, C. N DALTON, assistant secretary. T. R. Oakley, Esq., town clerk, Monmouth." A meeting is to be called to discuss the situation.

Yarmouth.—The Corporation monthly statement of the electric light shows that the receipts were £245. 12s. 11d, yielding an excess over the cost of production of £104. 5s. 5d. From this has to be deducted repayment of capital, interest, depreciation, etc, amounting to £85 or £90 per month. Applications had been received from nine more customers for 302 lamps, making a total of 120 customers using 5,789 lamps. The Council's expert, Mr. W. H. Preece, recommended that, in view of the rapidly increasing demand for the light, it would be advisable to put in the additional boilers and dynamos in time for next winter supply; that, instead of two 150-h.p boilers, two 200-h.p. boilers should be put in, and that, instead of three 75-kilowatt dynamos, two 150-kilowatt dynamos be put in. This will increase the capacity of the station from 13,500 to 15,750 lamps, without counting the gas-engine, and the cost will not exceed the amount of the loan sanctioned. Messrs. Jewson and Sons wrote asking when the light would be introduced into Southtown and Gorleston. The Southtown Gas Company also wrote offering to fit incandescent burners into about 100 lamps and charge the same rate as at present, providing the Corporation undertook to use the lamps for at least three years. Mr. Press hoped the Corporation would not assent to any such arrangement for shutting the electric light out of Southtown, which contributed one-fifth to the rates and had paid one-fifth of the initial cost of establishing the electric light. Gas was dearer in Southtown, and no part of the town needed the electric light more. He moved that the application be not entertained. The matter was eventually referred to the Sanitary Committee with power to act.

Taunton.—The Electric Lighting Committee have reported that the new switchboard at the works was completed, and they recommended that a sum of £250 be paid to Mr Newton on account of his contract. They also presented to the Town Council the agreement with Mr. H. G. Turner for laying an electric cable and supplying electric light to Pinkhurst, and recommended that the common seal of the borough be affixed thereto. Alderman Potter, in proposing the adoption of the report, said that he had just received an order for 120 more incandescent lamps. Councillor Wrenn complained of the electric light being put out before the men went to work early in the morning, which was very inconvenient. The report was adopted. Mr. H. W. Couzens, the electrical engineer, reported that the demand for the electric light was steadily increasing as hitherto, and 140 lamps of 16 c.p. had been added during the past quarter. The new switchboard was at work, and proved of great value to them in regulating and controlling the circuits. They were daily expecting the engine and alternator, which were rendered absolutely necessary by the increasing load. They had erected all the additional arc lamps ordered last spring, and were now running half the public lamps till 6 a.m.; the remainder (in less prominent positions) were switched off at midnight. The severe storm of Tuesday last started two connections to earth on the older type of lamps, and extinguished a section of the lamps in North Town and Park street for about two hours. They experienced the greatest difficulty in locating the faults owing to the wind and rain. The maximum load on the private lighting circuits was about 20 per cent. greater now than it was in the corresponding period of last year.

Leeds.—The minutes of the Highways Committee of the Corporation have included a resolution of the Tramways Sub-Committee that the necessary steps be taken for the extension of the Roundhay tramway to the Canal Gardens at the Park; that the overhead electric system be continued from the junction of the Roundhay tramway at Sheepscar, along North street and Briggate; that in Boar-lane, from Briggate so the Yorkshire Banking Company's premises, an installation of the conduit system be laid; that the overhead system be then continued along Wellington-street and Kirkstall-road to Kirkstall Abbey, and that central poles be used wherever practicable. The Tramway Sub-Committee had also adopted a resolution that Dr. Hopkinson be engaged to report to and advise them on the installation of overhead electricity and the short length of conduit referred to, such report to be made in view of the Council's resolution to carry out the electric system throughout the city. These resolutions had been confirmed by the Highways Committee. Alderman Firth, in moving the adoption of the minutes, said the committee were intensely anxious that the very best possible principle should be adopted, and as the city engineer felt that it would be better in the interests of the city that a competent expert should be asked to report upon what was the best system, and how best to carry it out, the committee selected Dr. Hopkinson. Whenever his report was presented the Council would not be committed to anything beyond receiving it and paying Dr. Hopkinson's fee. The report would, he hoped, be brought before the Council in due course, but it could not be acted upon without the consent of the Council. An amendment moved was lost, and the minutes of the committee were in the end adopted by 32 votes to 18.

Rotherham.—Mr. George Gummer has moved in the Town Council the appointment of a new committee to be called the Electric Lighting and Tramways Committee. He said he was sorry the Mayor, in his opening remarks, had rather thrown a damper on such an enterprise. He supposed the Mayor's idea was that it might involve the town in an amount of expenditure, but at the same time omitting to take account of the circumstance that a profitable revenue could be derived from one, if not both, of the systems. The committee would have a good deal of work to go on with in its initial stages because before it could possibly get into a position for the spending of money enquiries would have to be made as to the wisdom of putting in installations for electric lighting, and enquiries would have to be made from the local authorities of Rawmarsh and other places surrounding Rotherham as to the desirability of running trams from their townships into Rotherham. In regard to electric lighting Rotherham was very much behind. At the last meeting of the Municipal Buildings Committee a resolution was passed to the effect that enquiries should be made and an estimate asked for relative to the probable cost of an installation for the new municipal buildings. He, however considered it was unwise for a municipal body to deal with so important a question in a piece-meal fashion. If they went into the subject thoroughly it was possible they might induce several manufacturers and large tradesmen to adopt the light, for it was undoubtedly the light of the future. He thought that, instead of spending a large sum of money on the extension of gasworks, they ought to look ahead. Regarding the trams, his view was that they were bound to bring the surrounding population into closer proximity by giving increased facilities of communication. This forward movement would, if pursued, materially help on the prosperity of the town. The resolution was ultimately passed by 10 votes to 2.

New London Mains, etc.—The Highways Committee reported to the London County Council on Tuesday that they had considered (1) three notices, dated respectively October 30 and November 2 and 12, 1895, from the House-to-House Electric Light Supply Company of intention to lay mains and construct surface boxes (*a*) in Bramham-gardens and Collingham-gardens, (*b*) in Courtfield-gardens and Collingham-place, and (*c*) in Fulham-road. The proposed work was for high and low tension mains, and they recommended that the sanction of the Council be given to the works. (2) A further notice, dated November 1, 1895, by the same company, of intention to lay low-tension mains in Earl's Court-road. The proposed work appeared unobjectionable. (3) Also two notices, dated November 4 and 12, 1895, respectively, from the London Electric Supply Corporation, of intention to lay distributing mains (*a*) in Tooley-street and (*b*) in St. George's-road. They saw no objection to the proposed works. (4) An application from Messrs. Ellington and Woodall for the Council's consent to the laying of the London Hydraulic Power Company's mains in Kingsgate-street and part of Eagle-street. The consent of the Holborn District Board has been obtained, and the committee were advised that the proposed mains would not apparently interfere with any of the Council's works. They recommended that the sanction of the Council be given to the laying of the mains. The Bridges Committee reported that the National Telephone Company had applied for permission to lay a cable along Waterloo Bridge. The company proposed fixing a 2½in. cable upon the east cornice of the bridge and within a segmental galvanised iron casing, 9in. in width at the base by 5½in. in height. The casing is to be flanged at the base and to be attached to the cornice by means of lewis bolts let into the granite. As so large a casing would probably interfere with the architectural lines of the structure, the committee were of opinion that the company should be restricted to the use of a 3in. tube as at Hammersmith Bridge. With

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regard to the attachments, these should be made by narrow iron straps attached at intervals to the base of the plinth of the bridge, with the object of providing a means of drainage beneath the pipes. As to the rent to be paid by the company for the permission asked for, they suggested that an annual rent of £10 should be charged, which is the same rent that the Council charge the company for their cable across Hammersmith Bridge. The committee therefore recommended that the National Telephone Company be allowed to lay a telephone cable across Waterloo Bridge on the terms and conditions before mentioned.

PROVISIONAL PATENTS, 1895.

NOVEMBER 11.

21357. **Improvements in or connected with telegraphy and telephony, and in electric relays for use therewith.** Ernest Jules Pierre Mercadier and Henri Robert Joseph Pierquin, fils, 6, Lord street, Liverpool.

21367. **Improvements in electrical indicating and recording meters.** Reginald John Cumming Wood and Arthur Edward Mayes, 55 Chancery-lane, London.

21370. **Improvements in and relating to rotating brushes, applicable to moving electrical generators, motors, or machinery.** Sidney Allingham and Walter Angove Clatworthy, 1, Queen Victoria-street, London

21374 **Improvements in microphones.** Emil von Szvetics, 45, Holborn-viaduct, London.

21381. **Improved manufacture of carbon rods for arc lights.** Josef Roubal, 323, High Holborn, London. (Complete specification.)

NOVEMBER 12.

21433. **Improvements in the holders or carriers of electrical incandescent or glow lamps.** Richard George Evered, 7, Staple-inn, London.

21460. **Improvements in electric controllers and reversing switches for electric motors.** William Henry Morgan, 18, Buckingham-street, Strand, London. (Complete specification.)

NOVEMBER 13.

21498. **Improvements in carbons for electric arc lamps.** William Hastwell Clegg, 28, Broad-street, Birmingham.

21543. **Improvements in apparatus for transforming continuous electric currents into alternating currents.** Charles Denton Abel, 28, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour la transmission de la force par L'electricité, France.)

21556. **Improvements in microphones or telephone transmitters.** William Phillips Thompson, 6, Lord-street, Liverpool. (The firm of Hammacher and Paetzold, Germany.) (Complete specification)

21560. **Improvements in and relating to electric railways or tramways.** John Charles Love and John Earle Hodges, 45, Southampton-buildings, Chancery-lane, London.

21586. **Improvements in electrical railway systems.** John McLeod Murphy, William James Dixon and Albert Francis Pierce, 40, Chancery-lane, London. (Complete specification.)

NOVEMBER 14.

20164A **Improvements in or connected with cathodes for use in the electrolytic deposit of metals.** Sherard Osborne Cowper-Coles, Maurice Ulcoq, Walter Murray Guthrie, and Carrington Riddell Gordon Smythe, 47, Lincoln's-inn-fields, London. (Date claimed under Patents Rule 19, October 25, 1895.)

21601. **Electrical apparatus for destroying rats and like animals** Lena White, 53, Arcade-chambers, St. Mary's Gate, Manchester.

21623. **Improvements in the fittings of electric lamps.** William James Fox, 53, Ward's-buildings, Deansgate, Manchester. (Complete specification.)

21638. **Improvements in electrical switches.** John William Fielding, 27, Martin's-lane, Cannon-street, London.

21657. **Improvements in or relating to submarine telegraph cables.** Francis Cornwall Crawford, 323, High Holborn, London.

21664. **Improvements in or relating to the running of alternate-current dynamo-machines in parallel.** Robert Henry Fowler and Charles James Hall, 433, Strand, London.

21679. **Improved means for use with electric cables for diverting the current through adjacent cables when required for repairs or other purposes.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

NOVEMBER 15.

21752. **Improved system of using electric lights and other means of illumination.** Goymour Cuthbert, 6, Bream's-buildings, Chancery-lane, London.

21759. **Improvements in electric storage batteries or accumulators.** Thomas William Allan, Arthur Powell, and Charles John Tibbits, 65, Chancery-lane, London.

NOVEMBER 16.

21763. **Improvements in electric tramway or railway systems.** James Fairclough, 10, St. George's-crescent, Liverpool.

21798. **Improvements in and connected with telegraph and other signals.** James Nicolson, 22, Glasshouse-street, Regent-street, London.

21817. **A new or improved apparatus for conveniently carrying portable electrical batteries, books, or other articles.** Thomas William Allan, Arthur Powell, and Charles John Tibbits, 65, Chancery-lane, London.

21818. **Improvements in fittings for incandescent electric lamps.** Thomas William Allan, Arthur Powell, and Charles John Tibbits, 65, Chancery-lane, London.

21830. **Improvements in electrical apparatus for firing fuses for mines and other purposes.** Siemens Bros. and Co, Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

SPECIFICATIONS PUBLISHED.

1889.

16237 **Electrical mains.** De Ferranti. (Second edition.)

1893.

19809. **Carbons for electrodes, etc.** Castner. (Second edition.)

1894.

20170. **Electrical soldering and welding apparatus.** Zerener.

20746. **Electrical prepayment gas-meter.** Villiers-Stead.

21855 **Dynamo-electric machine cylinders, etc.** Adams and Crompton.

22458 **Electrically-propelled carriage.** King.

22460 **Electrically-propelled vehicles.** King.

24908. **Indicating etc., electric currents.** Blackburn.

25079. **Telegraphic transmitters.** Boult. (Spiro.)

25263. **Electric call bell.** Rogg.

1895.

2816. **Secondary batteries.** King.

4494 **Incandescence lamps.** Denayrouze. (Second edition.)

11728A. **Voltaic batteries.** Shaw.

15069. **Telephony.** Biggar.

16910. **Electric, etc., motors.** Regan.

17436. **Thermo-electric generators.** Cox.

17603. **Electric batteries.** Bair.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6¼
Brush Company, Ordinary	3	1⅝-1¾
—— Non. Cum., 6 per cent. Pref.	2	1⅞-2⅛
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5⅛-5¾
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6⅞-7¼
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	12¾-13¼
—— 6 per cent. Cumulative Pref.	10	15⅞-16¼
—— 5 per cent. Debenture Stock	100	131-135
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	132-134
—— 5 per cent. Pref. Shares	10	14⅜-15½
County of London and Brush Provincial Co., Ordinary	10	8¼-9⅛
—— 6 per cent. Cum. Pref.	6	8⅜-9⅛
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅞-2⅛
Edison and Swan United Ordinary	3	1⅝-2⅛
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅞-1
—— 7 per cent. Cumulative Pref.	2	2-2⅛
Elmore's Copper Depositing	2	⅜-⅝
Elmore's Wire Company	2	⅜-⅝
Fowler-Waring Cables	5	1-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	14-14½
—— 7 per cent. Preference	10	15½-16⅜
—— 4½ per cent. Debentures	100	108-111
House-to-House Company, Ordinary	5	4¼-4⅜
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	18½-19½
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge Ordinary	5	8-8½
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7⅞-8½
Liverpool Overhead Railway	10	11⅛-11⅜
—— 5 per cent. Pref.	10	15½-15⅝
—— 4 per cent. Mortgage Debentures of £100	100	112-114
London Electric Supply	5	⅝-¾
Metropolitan Electric Supply	10	10½-11½xd
—— 4½ per cent. First Mortgage Debenture Stock	100	117-120
National Telephone, Ordinary	5	6-6½
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15½-16½
—— 5 per cent. Non. Cum. Third Pref.	5	6¼-6½
—— 3½ per cent. Deb. Stock	100	105-107
Notting Hill Company	10	8¼-9½
Oriental and Electric Company, £1 shares	1	1-1⅛
—— £5 Shares	5	7⅛-8
—— £4½ shares	4½	6¼-6⅜
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-105
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8-8½
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	40-42
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4⅛-5
Westminster Electric Supply, Ordinary	5	8-8½
Yorkshire House-to-House	5	6½-7

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NOTES.

A November Fog in London costs, it is said, in gas, electric light, accidents, delays, and damage, £100,000.

Electric Fire Hazard.—The committee of the Insurance and Actuarial Society of Glasgow, in connection with the "present-day applications of electricity, with special reference to fire risk," have made arrangements with Mr. T. Crichton Fulton, A.I.E.E., and the first lecture was to be given yesterday evening in the lecture theatre of the Institution of Engineers and Shipbuilders, at 207, Bath-street, Glasgow.

Cantor Lectures.—On Monday, December 2, Mr. Worby Beaumont will commence at the Society of Arts a course of three Cantor lectures on the subject of "Mechanical Road Carriages." The first lecture will deal principally with the history of the subject, the second with general principles, and the third with an account of the more recent efforts which have been made to develop a system of mechanical vehicles for common roads.

Unfortunate Fish.—According to *L'Etincelle Electrique* (November 20), if an alternating current such as is obtained from a Ruhmkorff coil is sent through water, large metal electrodes being used, any fish passing between them are temporarily paralysed, and come to the surface belly upwards. Our contemporary, who appears totally regardless of the feelings of the legitimate angler, suggests this as a new way of fishing.

Acetylene may give rise to an interesting legal discussion in the United States. The Standard Oil Company has taken up acetylene, and is preparing to push it; but the Pittsburg Reduction Company, which has aluminium works at Niagara, says that it makes acetylene as a by-product in the manufacture of aluminium, and that it is not going to be interfered with by any acetylene patent. It is possible, however, that the two companies may come to terms.

The Dalmuir Electric Launch.—Messrs. R. and A. M'Donald, the inventors of the "Clydebank" battery, tested their new electric launch "Mystery" on Friday and Saturday last. It is stated that they ran the craft from Greenock to Glasgow and back to Kilpatrick, a distance of 36 miles, with one charge of the batteries, in 5¾ hours, and that they used 36 cells made of ebonite, each cell measuring 12in. by 4in. by 4in., weighing 8lb., and having a capacity of, per cell, 300 ampere-hours.

Horseless Carriages.—A meeting for the purpose of forming an association in connection with self-propelled traffic is to be held on Tuesday, December 10, at the Cannon-street Hotel, London, at three o'clock, at which Sir David Salomons will preside. Sir David Salomons has secured powerful support in the movement. A series of resolutions will be proposed at the meeting with the view to starting such an association. Mr. Andrew W. Barr, of 30, Moorgate-street, London, E.C., is acting as honorary secretary for the time being.

Electric Carriages.—At the Stanley Cycle Show at the Agricultural Hall, Islington, horseless vehicles were on view in two distinct types. One was the Daimler carriage, a full-sized phaeton driven by a petroleum motor. The other type was an electrically-propelled tricycle of the Olympia pattern called the Gladiator, the electric apparatus being mounted on the frame in front of the rider, and geared down to the crankshaft, upon which cranks and pedals were mounted in the usual way, to enable the rider to assist in the work if he should so please.

Magnetic Surgery.—A remarkable use of magnetism was made a few days ago at the New York Eye and Ear Infirmary. A piece of steel ⅜in. by ¼in. had accidentally become embedded in a man's eye, and the nature of the injury was such that a surgical operation was held to be inadvisable. A strong electromagnet was procured and placed before the patient. When the man's eyes were brought within a few inches of the poles of the magnet he uttered a cry of pain, and the piece of steel came to the surface of the eyeball, whence it was extracted.

Ampere's Blackboard.—Ampère, like other philosophers, was noted for his absent-mindedness. It is stated that on one occasion while walking along the street he mistook the back of a cab for a blackboard, and as a blackboard was just the thing he needed at the time to solve a problem which had been vexing his mind for some moments during his walk, he made use of it. Taking a piece of chalk out of his pocket he proceeded to trace out a number of algebraical formulæ on the cab's back, and followed the moving "board" for the space of a quarter of an hour without noticing the progress of the conveyance.

Competition for Government Electrical Posts in Italy.—In connection with the new imposts on gas-lighting and electric energy the Italian Government found it advisable to open a competition for the posts of working electricians to the number of 20 for the new official department thus rendered necessary. *L'Elettricità* (November 24) says that considerable dissatisfaction is expressed by would-be competitors in good permanent positions, that after being successfully examined and taken on in the order of graduation they will have to undergo a period of probation lasting four months before the appointment is ultimately confirmed.

Boron Battery.—This new Austrian battery consists of a plate of zinc and one of carbon covered with boron, the electrolyte being a solution of "manganese salt and other substances"; the voltage is 2·5 to 3, which is maintained for quite a long time; the cost of maintaining the battery is said to be one penny for a 10-hour run—but for what output is not stated. The novelty consists in covering the carbon plates with boron, which is done by immersing them at a high temperature in a bath of chloride or fluoride of boron, then in a solution of oxalate of platinum, after which they are heated to a red heat in an atmosphere of hydrogen. A plate so treated contains metallic boron in its pores.

The Bell Telephone Monopoly, the *Electrical Age* says, is undoubtedly on the verge of its grave; it has struck a "snag" in the United States Supreme Court. That Court has decided that it has jurisdiction over the case of the United States *v.* the Bell Telephone Company to cancel the Berliner patent, which case was decided against the Government by the Court of Appeals. The Bell Company argued that this latter decision was final, but the Supreme Court decided otherwise, which action will result in bringing the case to the Supreme Court for final decision. This decision, the journal adds, is a substantial victory for the independent telephone interests, and there is much rejoicing in consequence.

Rubber Cultivation in the Straits Settlements. Not alone in coffee are the Straits Settlements leading the way, but also, it seems, in respect of the cultivation of rubber. A Ceylon paper has received a visit from the proprietor of a plantation in Lower Perak on alluvial river-side soil, where there are either planted, or about to be planted, some 500 acres of Para rubber. The progress of the clearing, and the eventual harvests of rubber made by the experimentalist, Mr. Baker, will be watched with interest. In the past two years, however, a good deal has been done in Para rubber in Ceylon, especially in the

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Kalutara and other low-country districts. Perhaps 1,000 acres altogether are planted with rubber trees in Ceylon.

Talent for the Electric Railway Business.—A street railway manager in America is stated to have received the following interesting application for a "job": "dear sirs I have benadvized to write to you for A job on the St car as ime young and Active dear sirs if you want such A one please write me at once & Ill honest business & no other. ime young & if you need A hand & wish to try me ill go & if i dont do your work down me & get some one else I neve see A street car but ive neve tryed to do any thing with out strike at it ive been examined by & phenoligist & he said that I was suited up for mashinery & Ime ready to be ex amined by the best phenoligist if you wish to have me axamined please rite at once."

High-Voltage Shocks.—Signor Nizzola, in *L'Elettricista*, states that in the high-voltage plant installed in Frankfort-on-Main, a workman was carrying out some repairs in the distribution system when he touched a bare copper wire while standing in good contact with the ground. The wire was connected with the middle conductor of a concentric cable, the external conductor of which was maintained at about the same potential as the earth, owing to the capacity effects, the length of that circuit being 18 miles. He thus received a shock from 2,900 volts. He immediately fell to the ground, and remained for half an hour apparently dead. A bright spark was seen when he broke contact. Artificial respiration and throwing cold water on the breast gradually restored life, but he remained for a whole day in a dazed condition. He resumed his work again the next day, however, with no other effects remaining beyond a bad burn on the hand.

Turkish v. Persian Telegraph Poles.—An amusing story is told regarding the construction of a telegraph line from Bagdad, in Asia Minor, to the Persian capital of Teheran. The frontier line between Turkey and Persia was so indefinable that a track of no less than 17 miles of land over which the telegraph would have to be carried was in dispute, each of the two countries claiming the right to its possession. Now, the engineering stores supplied to the Turkish Government differed from those supplied to the Persian Government. The former had wooden telegraph poles, the latter iron ones. The Persian Government, in their jealous hatred of the Turks, feared that if wooden poles were erected across the disputed territory, posterity would regard them as proof that the territory was Turkish. On the other hand, the Turks objected to iron poles being used lest in the far future they should be adduced by Persia as evidence that the land was hers. The way in which the superintendent of the work contrived to get out of the difficulty did credit to his ingenuity and resource. He alternated the wood and iron poles for the whole 17 miles.

The Fastnet Cable.—The paragraph which has recently appeared in many of the daily papers relating to the breaking of the Fastnet Lighthouse and Crookhaven cable is, we understand, somewhat misleading. The communication is effected by means of the non-continuous cable system, first suggested by the late Mr. Willoughby Smith, and has worked satisfactorily for over four months. The system necessitates two short lengths of strong, bare copper cable being bolted to the rock from the lighthouse to the water's edge, and this can only be done when the sea is exceptionally smooth—a very rare thing at Fastnet. Owing, however, to the persistent bad weather, the cable down the north face of the rock could not be absolutely secured, and has, therefore, given way. Communication can be—and has been—maintained, except in the very roughest weather, by means of a temporary copper wire which the lighthouse men throw over the side of the rock so that the end just enters the water. The main cable, about nine miles long, which terminates at a mushroom submerged in the vicinity of the rock at a depth of about 80ft., still remains in perfect order.

An Electric Snow-Plough.—There has been on exhibition in Montreal a model of a new electric snow-plough to be used on street railways. It has attracted much attention, and has been endorsed by the city engineer. A steel scoop placed in front collects the snow. The scoop can be rapidly raised or lowered, leaving the required depth of snow on the street and between the rails. It can also be drawn across to right or left by a chain working on the shaft. The scoop projects about 6ft. over the side of the road from the rails, and clears the street for the vehicles. The removing plates are placed on an endless chain running around sprocket wheels placed at each end of the scoop, and, running across the scoop, draw the snow thus collected to the side of the road. Power to run the removing plates is taken from an electric motor placed on the platform of the car and conveyed by the chain to the sprocket wheel on the horizontal shaft, and thus by gear wheels to vertical shafts, on which are fixed the sprocket wheels, and around which the endless chain with plates runs. One scoop only is used at a time. On the return trip the car is switched on to the other track, and the back scoop, which is similarly fitted with plates, is used.

The Production of Pure Zinc.—An article by Herren Mylius and Fromm is abstracted in the *Electrochem. Zeit.* for October. To try to purify zinc by dry methods leads to no favourable results. The wet process can be carried out only with the aid of electrolysis, and this can be done in two ways—by the deposition of the metals from purified solutions with insoluble anodes, or by electrolytic refining with the use of soluble anodes of zinc. In their researches they used pure solutions of sulphate of zinc and obtained the following results: The pure zinc of commerce contains in all cases noticeable quantities of cadmium, lead, and iron. A solution of sulphate of zinc can be purified electrolytically so that chemical analysis cannot find any heavy foreign metals; zinc oxide is easily obtained by a chemical process, with the same purity; the electrolytic zinc obtained from zinc sulphate or oxide contains appreciable quantities of platinum which comes from the anode; the purest zinc is obtained by the repeated electrolytic reduction of the metal in basic zinc sulphate solutions, from which it is obtained in a spongy state, and must be melted in vacuum. The metal so obtained is not absolutely pure, but contains at least 99·99 per cent. of zinc. With the electrolytic decomposition of zinc the secondary decomposition of water cannot be prevented entirely. The formation of spongy zinc takes place by the action of the oxygen.

Death from Lightning.—The following appears in a letter to the *Lancet*: A number of soldiers at Aldershot were stationed under some small trees watching a cricket match when a sudden flash of lightning, like the bursting of a shell, was followed by cries for help from the men under one particular tree. Five men were found to have been more or less injured. No. 1, who had been sitting on the ground with his back against a tree from which a portion of the bark had been stripped close to his head, was dead; the breathing and pulse had ceased and artificial respiration failed to revive him. No. 2 was quite unconscious; the respiration had ceased, but the pulse was still perceptible. "In this case artificial respiration was rewarded after some minutes by a gradual return to consciousness." Brandy was then given; he was removed to hospital and soon recovered. Nos. 3, 4, and five recovered consciousness without artificial

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respiration some few minutes after being struck. The state of the pulse and breathing during the brief unconscious period is not mentioned. All the four men were able to return to duty within a few days. It is remarkable that the man who was killed had no marks of injury on the head or face, but No. 2 had his hair singed, and there were marks of burning (like ecchymosis) on the left side of the face, neck, and upper part of the chest. These cases afford interesting illustrations of three degrees of injury from lightning shock. No. 1 was fatally injured, with simultaneous arrest of the heart's action and breathing; No. 2 was unconscious, with suspended breathing, but was restored by artificial respiration; and Nos. 3, 4, and 5, temporarily unconscious, probably with suspended breathing, recovered from the shock without special assistance. The practical lesson is that one man's life was saved by artificial respiration.

"Locomotive Carriages for Common Roads."—This was the title of the paper which was read at the Society of Arts on Wednesday evening by Mr. H. H. Cunynghame. Sir Frederick Bramwell was in the chair, and among those present were Sir David Salomons, Mr. Shaw Lefevre, Mr. Hiram Maxim, Mr. Thornycroft, Prof. Hughes, and Mr. Vernon Boys. Reverting to the consideration of the various sources of power that might be utilised for mechanical carriages, the lecturer said that while electricity had been successfully applied to tramways, its use for ordinary road locomotion presented greater difficulties. Accumulators were very heavy, and in the case of road cars that was a serious consideration. To supply 1½ h.p. or 2 h.p. for 10 hours they would weigh about 1½ ton, and a carriage with that load would have practically no carrying capacity. However, both in this and in other countries electrical wagons and road carriages had been constructed. Referring to the carriages that competed in the Paris-Bordeaux race, Mr. Cunynghame felt bound to say that as regards design there was much room for improvement. He was surprised to see the cog-wheels made with cast teeth instead of the proper epicyclic teeth cut from the solid, as found in good machinery. One of the best-known carriages at present was that of the Comte de Dion, which was a pretty little machine moved either by the feet or by an electro-petroleum motor, or both. To Mr. Shaw Lefevre, he said, was due the credit of having taken up the question in the last Parliament, and there could be little doubt that if Parliament saw its way to remove the present restrictions the foundations would be laid of a great and lucrative industry. In the discussion which followed, Sir F. Bramwell, Mr. Shaw Lefevre, Sir David Salomons, Mr. H. Maxim, and the Comte de Dion took part. The discussion was ultimately adjourned.

Metallic Sodium in Electric Conduits.—The discovery of metallic sodium in the conduits at St. Pancras was questioned by many experts at the time owing to want of care in collecting the deposit. It has, however, now been confirmed by similar finds at Boston. The case has been reported on by Messrs. Forbes and Glidden for the Boston Fire Underwriters' Union, and relates to the examination of a substance found in a casing of the electric mains in the basement of the Pray building. The report was published in the *Electrical World*. It appears from it that the substance discovered was impure metallic sodium mixed with partially disintegrated wood, the metallic sodium being the product of electrolytic decomposition of impure sodium hydrate. This sodium hydrate came from the cement mortar used in laying the brick wall of the basement upon which the wires were supported. Some of the hydrate may have worked its way through the wall from the cement used in the foundation of the adjoining paved street. The electric current which caused the electrolytic action was due to a leak inside the casing from one of the mains to another, the leak having been produced by the action of the sodium hydrate on the insulating covering of the wires. Inside the casing the wires were partially covered by an insulating tubing composed of tarred paper. When the front of the casing was removed, the wires, tubing, and woodwork about this point were found to be covered with a thick liquid which had dried in places to a whitish substance resembling discoloured salt, and was slippery to the touch, and strongly corrosive. The metallic sodium was smoking, and, when moistened and struck with any hard substance, it gave off flashes of flame. The substance was determined to be metallic sodium by its appearance and characteristic reactions, and by its colour in the Bunsen flame. The insulation where the deposit occurred was practically destroyed.

The Future of Engineering.—The first lecture for the season under the auspices of the Dundee and North of Scotland Institute of Mechanical Engineers has been delivered in the Technical Institute by Mr. D. H. Saunders, who chose as his subject "The Solved Problems of Mechanical Engineering the Earnest of a Still Better Future." He said that the difficulties connected with turbines in Scotland were greatly increased by the shallowness of the rivers, which in winter were "goured." In Russia, where immense supplies of pure water could be had at all seasons of the year, the turbine was extremely successful, and on small mountain streams in Scotland, for blacksmiths' and joiners' shops and other small industries, it was an admirable motor. When there was an irregular water supply, and where large numbers of workers depended upon unfailing regularity in motive power, the turbine, however, was valueless. Speaking of electric lighting, Mr. Saunders gave an interesting account of the costs, and showed that in Dundee for each £1 worth of electric light the cost of the coal was 3s. 4d., or one-sixth of the whole cost, while in Glasgow it was, owing to the very much larger installation, only 1s. 8d. per £1 of the whole cost, or one-twelfth. It was therefore only the difference between this one-twelfth and the cost of any new motor which entered into the possibilities of a cheapened motive power. There were several difficulties which, no doubt, recent inventions had tended to increase, and which greatly discouraged the engineer in his efforts to make free use of water power. What was wanted now was an accumulator which would absorb the irregular power of the wind and river, and give it back in regular and constant motive power. It was perhaps more a problem for the chemist than the engineer; but was it impossible that by the force of river or wind or tide, the gases of which water consisted could be separated and packed in sealed chambers under hydraulic power, so that they could become the motive powers of ships and machinery? If a cheap and good mode of transmitting electrical energy could be invented, it would lead to the abolition of smoke in cities and grant many other benefits. The lecturer next directed attention to the enormous possibilities connected with a horseless carriage, and described what he had seen of this class of vehicle on the Continent. He predicted that the next great triumph in engineering would be connected with the horseless carriage.

Electricity in Paris.—At the recent meeting of the Société Internationale des Electriciens an important paper on the central stations in Paris was read by M. J. Laffargue from the technical point of view, and M. F. Meyer, of the Compagnie Continentale Edison, from the commercial standpoint. M. Laffargue passed in review the existing Parisian central stations — the Compagnie Edison, the Société

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d'éclairage et de force par l'électricité, the Clichy, the Compagnie parisienne d'air comprimé et d'électricité, the Champs-Elysées, the Left Bank, and the municipal works. The Compagnie Générale Edison has just put down, in its station in the Avenue Trudaine, a group of Brown generators of 680 kilowatts, which will increase the capacity of the plant to 3,080 kilowatts. The Societé d'eclairage et de force par l'électricité is effecting alterations in its works in the rue de Bordy. It is installing a Corliss-Farcot engine and dynamo of 600 h.p. The company's total capacity will then be 2,685 kilowatts. The Compagnie parisienne d'air comprimé, etc., is establishing in the Quai Jemmapes a new station for five-wire distribution, using Siemens dynamos. This company will have installed during the present year 2,400 kilowatts. It aims at replacing its sub-accumulator stations, to the number of 25, by three or four more important sub-stations with rotary transformers. The total capacity of this company is 4,600 kilowatts. The Société du Secteur des Champs-Elysées is about to put down a new 400-kilowatt Farcot alternator. The Société du Secteur de la rive gauche (Left Bank) is building at Issy a works of a capacity of 4,000 kilowatts in order to distribute electrical energy by 3,000-volt alternating currents. At the end of 1895 there will, therefore, be in the central stations of Paris a total disposable power of 19,108 kilowatts for running 454,000 10-c.p. lamps and 154 motors absorbing 331 kilowatts. The maximum daily consumption in Paris during October, 1895, was 6,778 kilowatts—at about six o'clock in the evening. The total energy consumed in one day has reached a maximum of 45,500 kilowatt-hours. The increase in the rate of the annual consumption of electrical energy in Paris has been constant since 1889. The figures are the following: 1889, 480,784 kilowatt-hours; 1890, 2,284,405; 1891, 4,761,706; 1892, 5,987,538; 1893, 6,986,927; 1894, 7,883,434 kilowatt hours. M. Laffargue then spoke of the private installations, which have a total capacity of 25,760 h.p. He criticised, finally, the establishment of private installations, but was forced to admit that in many cases they were cheaper than the electrical companies.

The Proposed Light Railways Association.—A meeting of gentlemen interested in the subject of light railways was held on Wednesday at 17, Victoria-street, Westminster, for the purpose of discussing the desirability of forming a light railways association, and the lines upon which it should be established. The chair was taken by Mr. W. J. Carruthers Wain (the president of the Tramways Institute), and amongst those present were Major-General Hutchinson, Major-General Webber, Major Rasch, M.P., Mr. H. M. Acworth, Mr. J. Elliott (secretary of the Tramways Institute of Great Britain and Ireland), Mr. Rose-Smith, C.E., Mr. P. W. Meek, etc. The Chairman, in opening the proceedings, remarked that some confusion has arisen in connection with the meeting, owing, no doubt, to the conference convened for Thursday by the Parish and District Councils Association. He desired at once to announce that there was no feeling of hostility on their part towards that meeting. Though they recognised the value of the assistance of the local governing bodies, which was most desirable in the interests of the light railway movement, still these bodies, he thought, could not promote light railways. A suggestion had been made that a council of practical men should meet in conference. He (the chairman) had recently returned from America, where he had been studying the question of the working of light railways in that country, and from what he had seen it was manifest to him and others that light railways could be made remunerative. He mentioned that Mr. Ritchie had expressed his readiness to receive a deputation from the association on the 6th proximo, and asked for information as to the points to be raised and the name of the gentlemen constituting the deputation. He then moved a resolution which recommended that a light railways association should be formed. General Webber, who seconded the proposition, observed that at a recent meeting of the British Association at Ipswich he argued that light railways could be constructed at a cost sufficiently reasonable to make them remunerative, in spite of the diminished traffic in the agricultural districts. The resolution was unanimously agreed to. The following committee was then nominated: General Hutchinson, Major-General Webber, Mr. A. C. Payne, Major Rasch, M.P., Sir Douglas Fox, Mr. Hamilton Smythe, Mr. W. J. Carruthers Wain, Mr. R. Harding Milward, the Duke of Sutherland, Lord Wantage, Mr. Beachcroft, of the London County Council, Dr. Carte and Mr. W. M. Murphy, of Dublin, with power to add to their number.

The Society of Arts and Technical Education.—In the course of his recent address as vice-president and chairman of the council of the Society of Arts, Major-General Sir John Donnelly said that there was a distinctly felt want of something between school and the workshop or the counting-house. The movement, commencing with Mr. Ewart's Commons Committee of 1835 on art instruction, culminated in the Act of 1889. In a general survey it was necessary to note what was being done in elementary schools, where, since 1891, drawing had been compulsory for boys in England and Wales, and optional with girls when cooking was taught. In the year ending August, 1895, drawing was taught in England and Wales to about 2,000,000 scholars. In Scotland, without compulsion, 250,000 scholars took drawing under the Science and Art Department, as did 62,200 scholars in Ireland. Grants were made by the Science and Art Department for manual instruction given to 45,000 scholars. For this and drawing grants and cost of examinations the cost was £200,000 a year. The Department's payment on results amounted to about £150,000 for science and £74,000 for art, excluding examinations and the cost of the higher institutions, museums, and the circulation of loans. Excluding the geological survey and objects for which grants were made outside technical instruction, those for objects within its scope amounted to £492,000, in addition to £212,000 for drawing and manual instruction in elementary schools and science and art instruction in training colleges. Much was done for purely technical instruction in schools and colleges under the Admiralty and the War Office and in industrial schools under the Poor-Law Board. The review would be incomplete if mention were not made of what was done by the City and Guilds Institute, by the City companies, and by the provincial colleges. The data available showed that all the 49 county councils and all the 61 county boroughs gave aid to the subjects included in the Science and Art Directory, such aid amounting to £185,000 out of the beer money. To technological subjects—electricity, engineering, sanitary science, and others included in the City and Guilds scheme—£90,000 was given by 33 county councils and 41 county boroughs. To commercial subjects, £50,000 was given by 46 county councils and 39 county boroughs. Manual instruction was aided by 46 county councils and 43 county boroughs to the amount of £65,000. Local authorities might avail themselves of the admirable examinations and inspections of the City and Guilds Institute, but local bodies took advantage of them only to a slight extent. Last year only 218 classes were so inspected, and about 11,600 candidates examined. The Society of Arts examined

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only 4,739 candidates, at 144 centres, in 11 commercial subjects. There were other examining bodies, Sir John Donnelly said in conclusion, but there was room and there was need for some central organisation to which local authorities might appeal.

Electric Locomotives.—Mr. Edgar Worthington read a paper on this subject before the members of the Manchester Association of Engineers on Saturday last. Countless experiments had, he said, been made with varied success to employ other material than steam and coal to haul goods and passengers upon a railway, but it had been left for electricity to make any serious encroachment on the domain of the steam locomotive. The last 20 years had seen such a rapid improvement in the construction of electric dynamos and motors that it would be rash to prophesy how far electricity would further supplant steam in the locomotives of the next 20 years. The commercially successful electric railway did not date further back than about 1886, when there were but 12 or 13 electric lines in the world. The year 1889 saw its introduction to Boston, U.S.A.—a city which in 1893 could drive 640 electric cars from one central station. The enormous development of electric tramways in America, Germany, England, France, and other countries had been principally in one direction—viz., by using an overhead conductor with a trolley running upon it connected to the car by a conducting pole. When he last visited America, in 1893, almost every town was provided with this type of electric railway running through the streets. The electric railways constructed by European engineers now numbered 81, with a total length of about 440 miles. There were 22 in Germany, 13 in England, and 11 in France. With regard to possible speeds, the lecturer said they were told that Mr. Weems, at Laurel (Mass.), ran an electric locomotive at 116 miles an hour, not long ago, using the overhead wire as a conductor. The subject of heavy electric locomotives was at present in an experimental stage and surrounded by practical difficulties which required the skill of the electrician's and mechanic's hand and brain before they could be pronounced commercially successful. The cost of operating electric tramways was frequently large during the initial stages, but, like every other mechanical contrivance, they ran more smoothly as they became better understood. The running expenses of the City and South London Railway for the first half of 1891 were 8·4d. per mile; for the corresponding half of 1893 they had fallen to 5·31d. The relative cost of operating tramways by electricity, horses, and steam, when each was in regular order, might be taken from the cost of three large typical tramways: electricity (City of London), 5·31d.; horses (Frankfort), 8·02d.; steam (Birmingham), average of four lines, 7·31d. They were thus brought to the conclusion that there was an important future before the electric locomotive. The chief direction in which it had been successful was in light suburban passenger traffic, superseding not only the horse trams, but also the ordinary railways. It was frequently spoken of as the "poor man's means of travel," and the thickly-populated counties of England seemed to be a promising field for its introduction. For underground service it was an assured success. Where water power was available, or an electric supply was already in existence, the working expenses of electric tramways were low. Even without these advantages the operating expenses of a frequent but not crowded service were lower than those of horse or steam worked tramways. The railway companies would, he thought, act wisely in developing electric feeding lines in thickly-populated districts, otherwise new competing electric railways were likely to spring up which might deprive the older companies of much of their local traffic.

Water Rheostats.—Mr. Geo. T. Hanchett says that many practical men do not know how universally water resistance may be applied, both for temporary and permanent service, in electric lighting and power work. It is often the case that a resistance of some kind is greatly desirable, if not absolutely necessary, and a few practical suggestions concerning the use of water resistances in such cases may not, he thinks, be amiss. The fluid in a water rheostat is not wholly water, as the name might imply, but consists of a mixture of water and some acid, usually sulphuric, which is added to vary the specific resistance. As the range obtainable by this procedure extends from one-tenth of an ohm, or even less, to several thousand ohms, the flexibility of the device is obvious, and it is practicable to prepare a water resistance to suit any voltage by varying the degree of acidulation. In the liquid are placed two terminal pieces, identical as to material, so as to obviate electrolytic action, and to these are attached the circuit wires. The proper shape and size of these terminals depend upon the volume of current to be passed through the device, and are also affected somewhat by the voltage. With large currents or very low voltage, or both, the terminals should be of large superficial area, and conversely. Water resistances are more often temporary devices, and therefore barrels, pails, etc., are frequently pressed into service. In cases where the apparatus is to be used for a few moments only, and the voltage is not dangerously high, a metal vessel is very convenient and satisfactory, the vessel itself constituting one terminal, and the other terminal being suspended therein. The resistance is decreased by gradually lowering the suspended terminal until it touches the bottom of the vessel, when the resistance is, of course, entirely cut out. However, it is not desirable to use any device in which the terminals tend to come together, except in cases like the one just mentioned, for the sudden removal of resistance from the circuit, caused by the accidental dropping of the suspended terminal, might result disastrously. A water resistance may be adjusted either by varying the distance between the terminals or by varying the terminal area submerged. The first method is preferable with heavy currents, and the second is better with small ones. The bulk of fluid necessarily depends upon the watts to be absorbed, regardless of voltage and current. For a steady load, free from sudden fluctuations, 20 kilowatts per barrel of fluid will be found to be a very satisfactory working figure. Experiment is usually the better way to determine how much acid is necessary, but for those who desire a guide to follow, the accompanying table is given:

Resistance of a Body of Liquid one square foot in Cross-section and 1ft. long

Pure water	about 100 ohms.
·174 per cent. acid	4·12 ,,
·435 ,, ,,	1·75 ,,
·724 ,, ,,	1·10 ,,
·985 ,, ,,	·85 ,,

The proportion of acid should be sufficient to enable the solution to absorb about one third the desired energy. The rest can readily be obtained by the adjustment of plates. In some cases, where a high voltage and a very small current are involved, as in voltmeter circuits, a water rheostat in column form will be found to give satisfactory results. Unfortunately, water resistances are prone to develop back E.M.F.'s., which preclude accurate measurements. To avoid this as far as possible in voltmeter circuits, a solution of zinc sulphate and two zinc terminals should be used. These, Mr. Hanchett says, produce a minimum back E.M.F.

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CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XVII.

(Specially Contributed.)

Erratum.—On p. 528, November 8, the electro-chemical equivalent of silver is given correctly in two instances, and in the other two a figure is omitted. In all cases read ·001118. By making the multiplication ·000010384 × 107·67 the student would have found the necessity of the missing figure.

Measurement by Magnetic Action.—Every wire carrying a current has a magnetic field, the intensity of which depends upon the strength of the current. When comparisons are to be made we must allow for differences of dielectric, but for our purpose we shall always assume that air is the medium in which the conductor or magnet is placed, unless the contrary is stated. Similarly, every magnet has its magnetic fields. Any magnetic field, whether that of a magnet or of a wire carrying current, resists the interference of any other magnetic field. The determining this resistance to interference of one field to another gives us one of the simplest means of measuring current.

Oersted — Ampere — Schweiger — Early in this century Prof. Oersted, of Copenhagen, thought, and in 1819 showed, that a magnetic needle—*i.e.*, a small magnet—suspended freely near a wire carrying a current was deflected from its position of rest by that current. Ampère investigated this, and expressed the results of this influence in the following manner:

Imagine an observer to form part of the conductor carrying the current, which passes through him, entering at his feet and leaving at his head, the deflection of a north pole will be towards his left hand if he is facing the magnet, as indicated in Figs. 1 and 2.

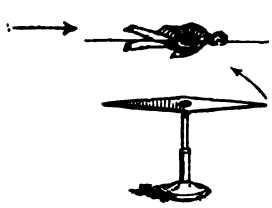

FIG. 1.

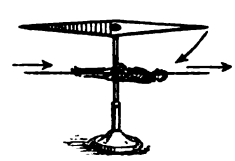

FIG. 2.

Prof. Schweiger, of Halle, soon after Oersted's discovery, by coiling the wire several times round the needle found that the deflecting force increased with the number of turns. This apparatus was called an electromagnetic multiplier, Fig. 3, and forms in some shape or other the basis of all our galvanometers.

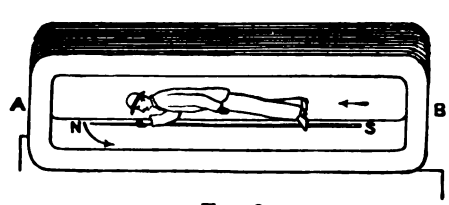

FIG. 3.

It may be mentioned here that the discovery of the action of a current upon a magnet is claimed for Grandominico Romagnosi, of Trent, who is said to have observed it in 1802 and published it in 1805. Anyhow it was a great discovery, and one that has been of enormous service to man. Successive inventors used the discovery in the construction of telegraphic and other apparatus, but not till recent years, when the idea of lines of force took hold of scientific minds, was any effort made to explain how the results were obtained.

A Stretch of the Imagination.—Writers of fiction make a great fuss about power of imagination; let us for a few moments enter their domain, and thus try to get a better grasp of magnetic interference. Then first try and imagine the earth as a magnet, its lines of force consisting of minute elastic threads stretching from north to south poles. These elastic threads are not so very very numerous through any square inch or square foot parallel to the plane of the magnetic equator. Mind, we imagine elastic threads, so that each thread, or part of thread, can be forced out of its original position. Each of these threads is to represent a line of force. Now suppose we make a small magnetic needle. This also has similar elastic threads, but the number of threads, or the number of threads through given area, is far feebler than that of the earth. It is evident that if we attempt to intermingle these elastic threads, the result will be, if the needle be free, that the elastic threads of the earth will force the elastic threads of the needle into a position parallel to their own, and that the poles of the needle will have the direction of the earth's lines. If we try to force the needle into any other position, the earth's lines oppose that force; hence we get two forces acting in opposite directions. Further, imagine a wire carrying current in proximity to the small magnet. The field of the wire imagine also composed of elastic threads, and far stronger than the field of the magnet or the field of the earth. The action of these threads is to try and turn the threads of the magnet into a direction parallel to themselves; similarly there is an attempt to force the earth threads into a position parallel to the threads of the wire. The earth's threads being elastic and those of the wire being stronger, the former are turned out of their normal course, and the small needle lines with them. Thus we get the earth's lines forced out of their normal direction, and the needle's lines, and therefore poles, following them. The extent of this deviation is a measure of the intensity of the current's field, and thus of the current.

Resultant Forces and Resultant Motions.—If we have a body or mass, M, acted on by a force F in the direction shown by the arrow, the motion of M, if motion there be, will be in the direction F, Fig. 4. If the mass, M, is

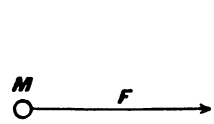

FIG. 4.

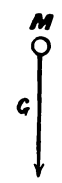

FIG. 5.

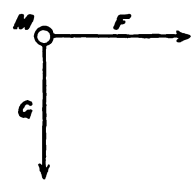

FIG. 6.

acted upon by a force G acting in the direction shown (Fig. 5), and there is any motion of M, the motion will be in the direction G. If, however, the mass, M, be acted upon at the same time by the forces, F and G, in the directions shown by the arrows, Fig. 6, the motion of M, if any, will be neither in the direction of F nor in the direction G, but in a direction somewhere between F and G, determined by the magnitude of the forces. If F is equal in magnitude to G, there is no reason why M should move in a direction nearer to F than to G, and, in fact, it would move in a direction midway between the two. If F is greater than G, then the direction of motion of M will be nearer F than G. If we represent the magnitude and direction of the forces acting by the length and direction of straight lines, we can easily geometrically, and in many cases easily arithmetically, ascertain the direction of motion and the magnitude of the one force which, acting in the direction of motion, would exactly replace the other two. Thus, if the mass, M, be acted upon by a force M F = 4 and a force M G = 3 in the directions respectively, as shown (Fig. 7) by

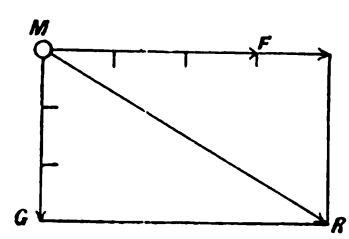

FIG. 7.

the arrows, then M will move in the direction M R, and the forces M F, M G might be exactly replaced by a force indicated in magnitude and direction by M R. The line M R is merely the diagonal of the completed

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parallelogram M F R G, of which M F, M G form adjacent sides. M R thus represents what is called the resultant force, or the single equivalent force that would replace M F, M G, and this motion, M R, would be the resultant motion of the forces M F, M G. What I want to particularly impress upon you is the fact that the resultant makes an angle with the forces, and the magnitude of the angle with either force is determined by the magnitude of the force. You can draw lines to each to represent forces, complete the parallelograms, draw the diagonals, and see this for yourselves. I want to trespass as little as possible upon another branch of your studies, but must ask you to accompany me just a little further among these forces.

Couple—Moment of Couple—Torque.—Suppose we have a rigid body, B A (Fig. 8), and have two equal and oppo-

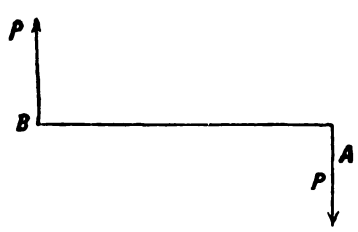

FIG. 8.

site parallel forces, P P, in the same plane acting upon this rigid body; the effect of those forces cannot be represented by a single force, for the tendency is to twist the body in direction of the plane in which the forces act. The term **couple** is applied to such a system of forces. The product of the numbers representing one force and the arm of the couple is called the moment of the couple. Thus, if P represents the force and B A the arm, the product P × B A = the moment of the couple represented. This applied to a magnet gives the force of one pole multiplied by the length of the axis of the magnet as the moment of the magnet.

A couple tending to twist a body in the same direction as the hands of a watch is termed a positive couple; if in the opposite direction, a negative couple. Electrical engineers use the term **torque** instead of moment of couple.

The Tangent Galvanometer.—Suppose we have a circular conductor, A B C D, placed in the plane of the earth's magnetic meridian, and suspend a very small magnet

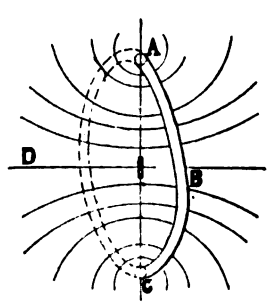

FIG. 9.

at the centre of this ring conductor, with its axis in the magnetic meridian, Fig. 9, then—

1. The lines of force of the magnet and the lines of force of the earth are parallel. Thus the magnet is at rest. Its poles being placed in the magnetic north and south so that it should be at rest.

2. If an electric current is sent through the conducting ring, the current produces its magnetic field around the ring, and the lines of force making the field of the conducting ring are at *right angles to the earth's lines of force and also to the magnet's lines of force.*

3. If the length of the magnet is small compared with the diameter of the ring—say, one-twentieth—we may take the field of the ring acting upon the magnet as a uniform field.

4. The effect of this conductor's field is to tend to turn the magnet, so that the lines of force of the field of the magnet are parallel to the lines of force of the conductor's field.

5. Hence we get two forces acting on the magnet:

   a. That of the earth's field tending to keep the magnet poles pointing north and south,

   β. That of the conductor's field tending to turn the magnet poles to a position pointing east and west.

The magnet, under these conditions, will move from its original position, and its poles will point in a direction that is neither north and south or east and west. The larger the current through the coil, the larger will be the deviation from the magnet's original position.

Now we are in a position to determine the law which governs the needle under the action of a current in the coil. It must be remembered that the action on one pole is equal and opposite to that on the other.

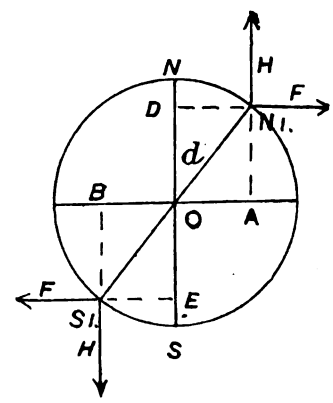

FIG. 10.

Let N S, Fig. 10, represent the magnet in the plane of the coil, both magnet and coil being in the plane of the magnetic meridian.

Let N_1 S_1 be the new position of the magnet when a current is sent through the coil.

Let *d* be the angle through which the needle is deflected.

H, as usual, is the horizontal intensity of the earth's magnetism.

Let F be the force due to the current.

Then the moment of couple due to earth's magnetism = H × A B.

And the moment of couple due to current = F × D E.

But when the magnet is at rest these couples are equal—that is,

$$F \times DE = H \times AB;$$

whence

$$F = H \times \frac{AB}{DE};$$

$$= H \times \frac{AO}{DO};$$

$$= H \tan d,$$

which gives the law: "The magnetic force which, acting at right angles to the magnetic meridian, produces on a magnet the deflection, *d*, is equal to the horizontal force of the earth's magnetism at that point multiplied by the tangent of the angle of deflection."

At any one place H may be taken as constant, hence the current varies as the tangent of the angle of deflection. It must be noted that the strengths of current are relative only. Currents can thus be compared with one another.

In using a tangent galvanometer the aim should be to get deflection as near to 45deg. as possible, because this is the most sensitive deflection of the instrument. If two currents are to be compared, obtain deflections as near as possible at equal distances on the two sides of 45deg. Thus, if it is desired to get a current double of another, let the apparatus be so arranged as to give with the smaller current, say, a deflection of 30deg.

Tan of 30deg. = ·5773503.

A current of double strength will give a deflection in degrees of which

the tan = 2 × ·5773503 = 1·1547006, or 46deg. 6′ nearly.

To obtain the value of the current in amperes we must know the constant of the galvanometer (which is $\frac{r}{2\pi}$ with one turn of wire in the coil, and $\frac{r}{2\pi n}$ with *n* turns in the coil) and divide by 10 because the practical unit of current

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is one-tenth of the theoretical or absolute unit. The formula for amperes becomes

$$C = \frac{r}{2\pi n} H \tan d \frac{1}{10}.$$

Such a galvanometer as that described, however, is not suitable for engineering work.

We may represent by means of a diagram (Fig. 11) the relation which exists between the current strength and the angle of deviation. The action of the earth's field *may be taken as constant*, though as a matter of fact it is rarely constant except through minute periods of time. Represent this

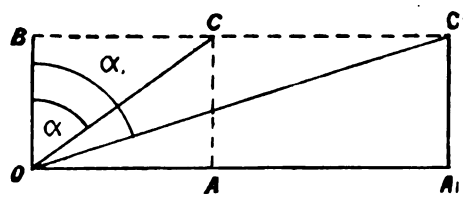

Fig. 11.

action by the vertical line O B. The current field acts at right angles to the field of the magnet, and as the strength of the field is proportional to the strength of the current, we may represent it or the current by the line O A. Complete the parallelogram O B C A, and draw the diagonal O C. The resultant of O B, O A, or the one force that would replace O B, O A, is represented in direction and magnitude by C O, and the deviation of the magnet by the angle α.

If we double the current strength it is then represented by O A_1, and the resultant force is now represented by C_1 O, and the angle of deviation by α_1. If this diagram was to scale, of course the arithmetical value of tan α_1 would be = 2 tan α.

In order to save the trouble of examining a table of tangents and making these arithmetical calculations, the instrument makers frequently give scales on their instruments for direct reading. The divisions on these scales are unequal, and obtained from this tangent law.

(To be continued.)

THE REACTANCE SYSTEM OF ARC LIGHTING.*

BY WILLIAM SMITH HORRY.

1. It cannot be denied that there is some room for improvement in arc lighting. The numerous and comparatively small dynamos, each supplying its own line, is quite out of place in a large arc light plant, and these, besides being theoretically inefficient, give more trouble and take up more room than would one or two large generators each capable of supplying a whole city in a business-like way. Our other electrical industries have all been greatly improved by the systematic use of large and efficient generating units at the station. The series arc lighting system alone has been left unimproved in this respect, and this industry may therefore be looked upon as being still in a state of transition.

It would be difficult, in the present state of the art, to design an arc light station capable of the lighting of a large city in any way comparable for economy to, say, an incandescent lighting or electric railway plant, for the reason that our manufacturers have not yet given us a comprehensive system of arc lighting. What we have now is good as far as it goes. Our half acre of dynamos, etc., is all very well, but surely something better is coming.

It must be admitted that the alternating arc lamp has done much to settle many problems connected with the supply of commercial arc lights; its introduction has been rapid and satisfactory, and it bids fair to become more used in the future as its economy becomes more appreciated, but for street-lighting with transformers there are still some hindrances to its use, and at present the series system is the only one that need be considered for this class of work.

2. A method of working arc lamp in series from the primary circuit of alternators without using a transformer, resistances, fuses, etc., to each lamp, and which is quite comprehensive enough for modern times, since a whole city can by this method be lighted from one machine, may be deemed of sufficient interest to warrant this description. The generator employed is the ordinary alternator that we are so familiar with in transformer lighting, and the lamp is also the ordinary constant-potential alternating arc lamp; and neither is changed in any way, so that different types of lamps, as of dynamos, are unnecessary. One lamp, and that of the most simple construction possible, is substituted for all purposes.

The type of lamp alluded to has already been brought to a high state of perfection, and it is, moreover, the most simple and elementary lamp that can be conceived. It has but one solenoid which is in series with the arc, no shunt spool, no cut-out, and is very reliable in consequence of having so few parts. These can now be procured in such sizes as to run for as many as 16 hours on this system without new carbons, and all-night lighting with this lamp becomes a fact.

If a choke coil, properly designed, be placed across the terminals of such lamps as these, arranged in series, each lamp will be found to regulate perfectly if the voltage at the end of the series be kept constant. The lamps, if of 1,200 c.p. will be found to take about 30 volts each. The choke coil need only be a small one, and need weigh but a few ounces. It consists of a little core of highly-laminated iron wound with wire in such a manner that the passage of even a small current will magnetise the iron very highly. The arrangement is shown in Fig. 1.

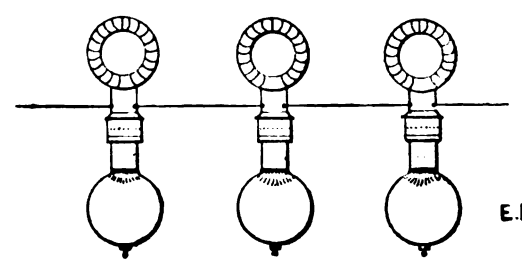

Fig. 1.

For practical work, however, thick wire must be employed, so that when the carbons are all burned away, the winding will take the whole lamp current continuously without injury to itself. Such a coil fitted to a lamp of 1,200 c.p. will weigh about 3lb.

3. Upon this principle the "reactance system" of arc lighting has been founded and so named because the reactance of a secondary or derived circuit causes the regulation of the lamp which is installed in series with others in the primary line.

The precise mode of operation is radically different from any other system. We have a line of many arc lamps in series, so that there is to all intents and purposes a constant current passing. Each lamp has a choking coil across its terminals, in shunt with the arc, so that there are two paths for the current, one between the carbons and the other round the impedance coil. With only a few volts difference of potential at the terminals, the current will be all choked out of the coil and all will pass through the arc, it lighting up the lamp the instant the current is turned on. As the carbons burn away the voltage at the lamp terminals will rise and the little coil will begin to leak. The impeding or choking power of an induction coil breaks down as the iron composing its core approaches to magnetic saturation. The result is that the arc is robbed of some of the line current, and therefore the lamp solenoid releases its hold on the carbon and causes the lamp to feed. It is found in practice that this device is very thorough. It takes care of the lamp whatever happens—makes it start up at once, keeps the voltage on the arc constant, and the lamp carbons may be open-circuited or short-circuited without any damage accruing to either the lamp or the line.

4. These are new effects in series arc lighting. There was never before such a controlling device, which containing absolutely no mechanism, yet at the right time performs the functions of a starting box, transformer, shunt solenoid,

* From the *Electrical Engineer* (New York).

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automatic cut-out, and line compensator, and which is possessed of all the qualities necessary to perform each of these duties at the right moment and with unfailing certainty.

To give an idea of the current that passes through an arc lamp when this regulating coil is employed in shunt with it, a table is given below, and a diagram (Fig. 2) illustrates it graphically.

Amperes actually passing through the arc.	Volts at terminals of lamp.	Observations.
12	0	Carbons touching.
11·2	20	—
10·8	25	—
10	28	Lamp working properly.
9·4	30	
9	32	—
0	36	Carbons separated.

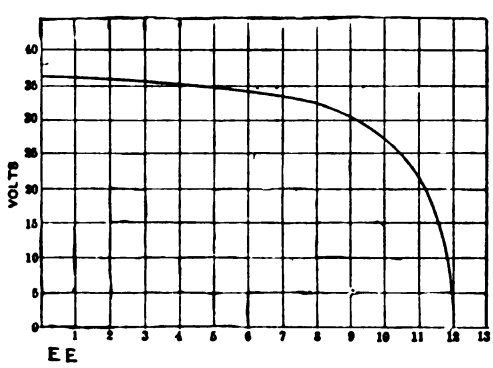

FIG. 2.

These measurements were taken on a line of 35 lamps arranged in series as in Fig. 1, working at 133 ⁓ from the primary circuit of a 1,000-volt alternator. The line current in this instance was 12 amperes. It may be remarked that in this case it was necessary to employ a 12-ampere line, as by this means the lamp started up very perfectly, and never failed to burn.

The line adopted in the "reactance" system, however, is generally 10 amperes, and a diagram of the circuits is shown in Fig. 3. In this way a 2,000-volt alternator will run 60 lamps in series each of 1,200 c.p., though in practice, over eight miles of No. 8 wire, it was found that only about 52 could be run in one series.

The system is automatic over a very wide range. Thus, if in a line of 30 arc lamps, five are extinguished in consequence of the carbons having all burned away, the remainder will run on just the same and the ampere-meter at the station will not be sensibly affected. This automatic regulation is a very good feature of the system, and it amounts in practice to 33 per cent. of the lamps for which the line is adjusted.

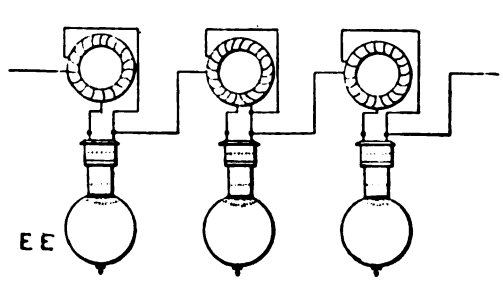

FIG. 3.

5. The efficiency of the device may be dismissed with a very few words. The amperes that flow through the coil are almost entirely wattless, and the whole device is exceedingly efficient. A wattmeter measurement shows the coil to consume about seven watts, and small though this may appear, the measurement has been taken again and again, with the most perfect instruments, with the arc lamp working, and its correctness is beyond question. This applies only to the coil employed with a 1,200 c.p. arc lamp; with a full 2,000-c.p. arc lamp the loss is about 40 watts, because in the case measured the arc-regulating coil had to act as transformer as well. The iron in the core of course gets hot, and for this reason only very little iron is employed—highly saturated.

The switchboard employed with the reactance system is shown in Fig. 6. It consists of an ampere-meter and a pilot lamp—10 amperes—a double-pole switch, a fuse block, and a series of contacts for throwing more or less impedance into the line. Lamps of 1,200 c.p. are installed as in Figs. 4 or 5, but larger arcs are generally fitted as in Fig. 4. It may be pointed out that lamps of widely different power can be connected in the same line, and that though the voltage on a 1,200-c.p. lamp is about 30, the larger arcs work better with less, say 24, and that only on this reactance system is it practical to give each lamp the voltage best suited to its needs at all times.

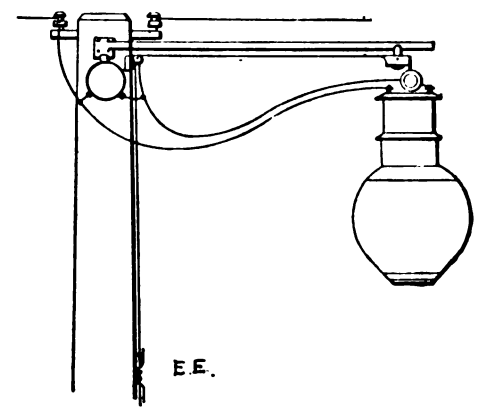

FIG. 4.

But the most important item of all, more important even than high efficiency, is certainty of operation. In this respect the "reactance" system leaves nothing to be desired. The coils cannot burn out, as they will take the whole lamp current without injury. Lightning cannot hurt them. There are no fuses to blow or to attend to. Altogether, the system is as hardy as it is possible for it to be. It is also possible by this system to use a carbon of great length, and to regulate it so that the length of the arc is invariable, whether these carbons be just lighted or nearly all burned away; and the arc regulators being so small the period makes little difference. A little larger core is all the change necessary for a regulator to work with 60 ⁓ instead of 133 ⁓.

It is obvious that any number of lamps can in this way be run from one alternator. Step-up transformers can be employed to run 100 or more arc lamps on one line or with two lines double that number. For indoors, one

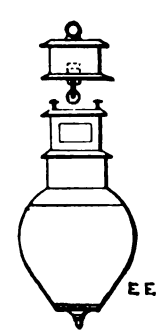

FIG. 5.

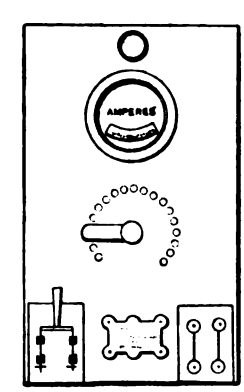

FIG. 6.

large building is lighted with 10 arc lamps supplied, as in Fig. 5, from a transformer secondary circuit of 300 volts. This greatly simplifies the wiring. The system works equally well on a constant alternating-current dynamo or on a constant-potential machine, and the lamps can all be worked on the secondary constant-potential circuit, if necessary, in the ordinary way.

It is considered a great gain to dispense with the cost of transformers for street-lighting, and it is hoped that when the extreme economy of the "reactance" system is appreciated, it will be found to be an improvement on existing practice and a step forward in the right direction.

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LARGE ALTERNATOR AT DEPTFORD.

The Deptford station of the London Electric Supply Company was originally designed to be the home of large generators. Although some of the earlier projects for the building of gigantic alternators direct coupled to engines of the marine type failed to be realised, the station has for years held the British record for the alternator of largest output driven by ropes. The enterprise of the company has again been exemplified by the laying down of what is certainly the largest direct-driven plant in Europe. This alternator, which, it is interesting to note, has been designed and manufactured by the originator of the Deptford station, Mr. S. Z. de Ferranti, is capable of delivering 1,000 kilowatts at the high pressure of 10,000 volts when running at a speed of 156 revolutions per minute. It is coupled to an engine, made by Plenty and Co., on the lines suggested by Mr. P. W. D'Alton. This engine consists practically of three vertical compound tandem engines working on to three cranks at 120deg. As a consequence, the turning moment is exceedingly evenly distributed over the different parts of the revolution. The foundations required by this large set are placed on the site originally intended to contain the projected 10,000-kilowatt set. The foundation block stands on the original floor, which consists of a 6ft. layer of concrete. The size of the foundation required will be gathered from Fig. 1, which shows the concrete block before the machinery was placed on it. The weight of concrete in this block reaches the enormous figure of 360 tons. The illustration shows the access provided to get at the foundation bolts and into the alternator-pit. The surface of the block, as will be seen from the views of the complete plant, is somewhat below the floor-line of the adjacent parts of the engine-room, but the platform round the plant will be more easily kept clear from obstructions in consequence.

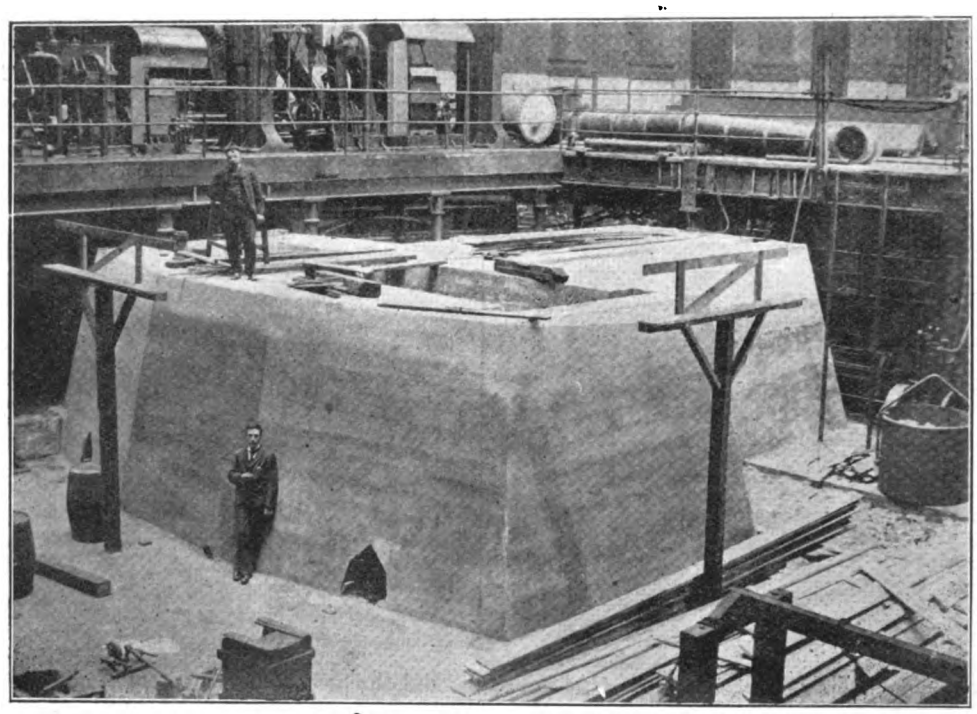

FIG. 1.—Foundation for the Large Steam-Alternator.

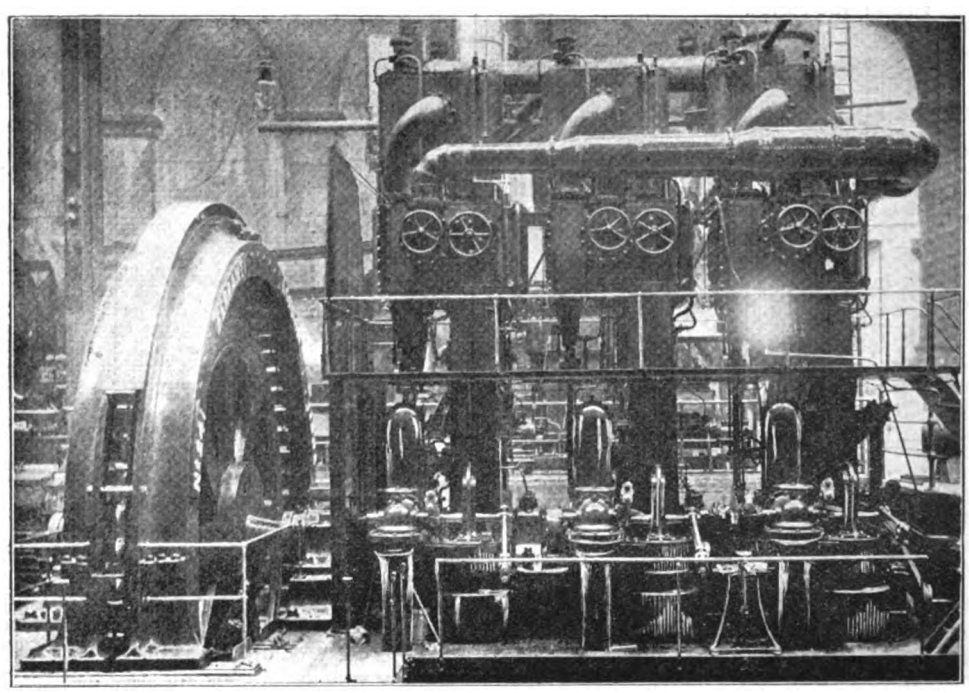

FIG. 2.—Side View of 1,500-h.p. Engine, showing Air-Pumps, etc.

The design of the engine shows Mr. D'Alton's appreciation for the essentials of the good parallel working of

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alternators. The rest of the engines in the station show progressive steps towards an even turning moment. It will be of interest to briefly refer to these. The worst offenders are the two horizontal engines of the Corliss type, which drive by ropes the two 500-kilowatt alternators, which were originally used in the Grosvenor-square station.

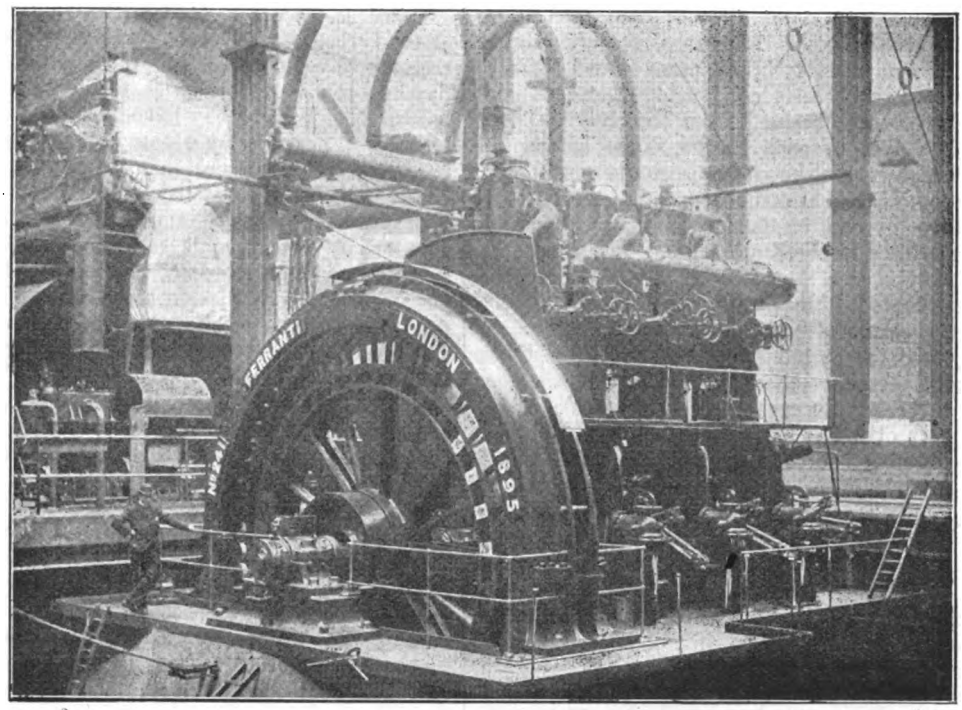

FIG. 3.—General View of the 1,000-K.W. Alternator.

These engines, being of single-crank type, with tandem cylinders, give a most irregular crank effort. The light-load plant consists of two 225-kilowatt Ferranti alternators geared by ropes to two 350-h.p. engines by Plenty and Co. These engines are triple expansion, and have three cranks at 120deg. At full load the work done in each of the three cylinders is nearly the same, but at light loads the high-pressure cranks do most of the work. The turning effort is then unsatisfactory. The remaining two sets are engined by the same firm with the marine type of engine, having a large rope pulley between the two cranks. These engines develop about 1,500 h.p., and drive the two 1,000-kilowatt alternators. They are compound engines, and hence have the fault that the division of work between the cylinders varies very largely with the load. The fact remains that, in spite of the widely-different designs of these three types of engines now in regular use, they all do work in parallel, and that when synchronised they hold in well. It is when switching out of parallel that the irregularity in the crank effort diagram is objectionable. The variation in turning moment causes a corresponding increase in the synchronising current, which represents the transference of power from one engine to the other, and keeps the machine in parallel. It then becomes almost impossible, owing to the oscillation of the ammeter needle, to determine the correct moment for switching the lightly-loaded alternator out of circuit. With practice and the care exercised at Deptford the recording voltmeter shows but a slight kick when the machines are taken out.

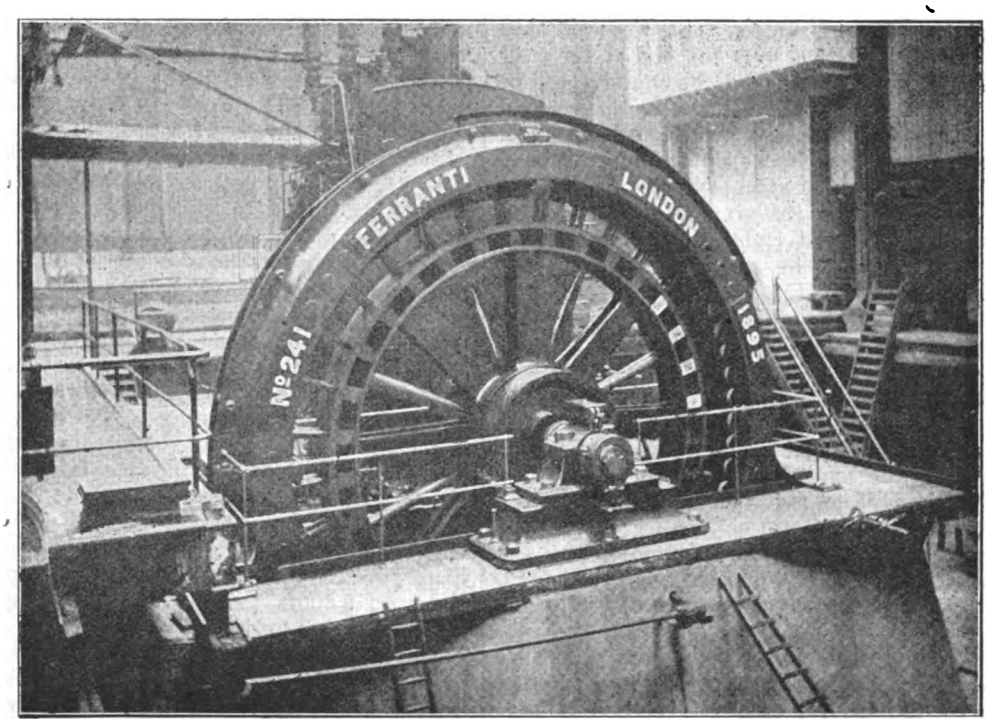

FIG. 4.—End View of 1,000-K.W. Alternator.

The new engines were designed with a special reference

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to this question. They consist of three vertical compound tandem engines placed in line. The high-pressure cylinders are directly above the low-pressure cylinders, as will be seen from the side view (Fig. 2). The diameters of the cylinders are 16½in. and 37in. respectively, and the stroke is 26in. Each separate engine will develop 500 h.p. when supplied with steam at 140lb. All the parts have, however, been constructed to stand 200lb. pressure, as when heavy demand arises the boiler pressure is raised. Hence the engines can on emergency supply more than 1,500 h.p. The back columns are used as condensing-chambers, the water for the spray being obtained from the river. There are two exhaust valves to each engine, as can be seen in Fig. 2, one of which passes the steam into the condensers, and the other connecting to the atmosphere. The air-pumps are worked by rocking levers, the links to which are shown disconnected in the illustration. The valve gear is of Joyce's new type, the alteration in the throw of the eccentric being effected by hydraulic pressure. For this purpose the main crankshafts have a hole through them communicating with a cylinder in each of the three eccentrics. The pressure in these is opposed by a strong spring. The governor, by means of a hydraulic relay, varies the quantity of water in these cylinders, and hence varies the point of cut off in each cylinder. A small pump maintains the hydraulic pressure when the engine is running, and a hand pump is provided to move the eccentric over when starting. The high-pressure slide-valve is of the cylindrical type, the low-pressure slide-valve being flat.

The construction of the wheel on which the armature of the alternator is supported is deserving of special notice, both on account of the high circumferential speed at which it runs and the precautions adopted to make it perfectly safe. The details of the wheel are shown by Figs. 2, 3, and 4. Following the construction in order of building up, the first operation consisted of shrinking on to the turned shaft a steel boss having eight large radial holes drilled and tapped in it. The wheel itself is cast in two halves, each half having four double T-arms which rest on the boss. The inner end of these arms were not joined together in casting, so that each was free to move as contraction took place. These two halves of the wheel were faced at the joints, and are turned both in the rim and at the centre. The wheel is then secured in position by shrinking over the end of the arms two heavy steel rings. The ring on the one side can be easily seen in Fig. 2. The two halves are also bound together at the rim by shrinking oval-shaped straps of rectangular section over projections on the inner side of the rim. These straps are of steel, and have the same section as the rings securing the arms to the boss. The next step is the introduction of eight strong radial spokes of cast steel to help take the bursting stress. These have flanged heads let into the rim and screwed into the boss referred to above. The method of securing uniform stress in each of these is as follows: The eight spokes are screwed up as far as possible when cold, and then are carefully marked. A calculation is then made as to how much further they must be turned to give a definite strain in them. This position is marked, and the spokes are heated *in situ* till the expansion allows of their being readily turned in the position required. On cooling, therefore, each spoke exerts a uniform binding pressure on the rim. The design was based on the assumption that the wheel should carry twice the weight at twice the speed, and the careful workmanship has resulted in a wheel which runs perfectly true.

The armature of the alternator is built up on somewhat similar lines as in the older Ferranti machines running at Deptford, but with improved details. The internal segments have cores made of laminated brass and asbestos, keyed together by corrugations in the brass. The smaller end is of solid brass burnt on to the strips, and to this is connected the inner end of the bare copper conductor. The segment is then wound with the conductor, which has corrugations to prevent side displacement, and the adjacent turns are insulated by special fibrous material. Two adjacent segments are clamped together into one carrier, and the outside ends of these conductors are connected where they touch. The two bolts clamping them into the carrier then form the two connections to the segments. The insulation between the carrier and the coils is effected by micanite shields. The carriers consist of two heavy brass castings clamped on to the segments. The complete carrier is supported on two bolts projecting from the rim. The insulation of these bolts is a matter of the greatest importance. They are ebonised all over except at the thread. The heads, screwed on, which come in the rim are covered with ⅜in. of ebonite. The rim of the flywheel is cast with a series of chambers to contain these boltheads. When they have been inserted and are held exactly in position by a template, the surrounding space is cast in with a special insulating compound of sulphur. These bolts are then tested with 20,000 volts between the metal at the screwed end and the rim of the wheel. The whole armature is connected up into two parallel circuits in such a way as to prevent any large difference of potential between adjacent segments. The connections are made from diametrically opposite points on the armature. The one point is earthed by being connected on to the rim of the wheel, and the opposite point, which is at 10,000 volts above the earth, is led by highly insulated connection to a collector in the front of machine. The bolts supporting the carriers near the high-tension connection have extra insulation on them, consisting of a series of ebonite collars, which increase the length of surface liable to leakage. The field-magnet castings are built up in two halves, one supporting the magnets on each side of the armature. Each half is formed of four segments securely bolted together. The poles, of which there are 64 on each side, are of circular section, and are forced into holes in these castings by hydraulic pressure. The diameter of the poles is so arranged that the fit in the casting practically secures them, but they are also clamped by cup-shaped set screws. The field coils are constructed by winding bare copper strip on edge into a spiral, with insulation between adjacent turns. The whole of these coils are connected in series, and we are informed that at full load the machine will require about 1 per cent. of the full power for excitation. The section of the magnets is not increased at the pole-faces. The danger of the high voltage from the bare copper of the armature sparking across to the field has been overcome in this case by placing micanite caps over the poles. These caps, which are about ⅛in. thick, have all been tested up to 25,000 volts. Since being in use no faults have developed in them up to the present. The caps are enamelled on the outside, and even then have to be wiped all over after about every 24 hours of running to prevent surface leakage. To enable this to be readily done, the two halves of the field-magnet system are made to slide, and are moved apart by a screw gear driven by an electric motor. This electric gearing is placed on the edge of the armature pit next to the engine, and by means of it the magnets can be separated in five minutes. In fact, on a special occasion it was found that threequarters of an hour was all the time taken to separate the fields, to remove a defective segment, to replace it by a new one, and to bring the magnets back into the position for running.

Some idea of the size of the machine can be gained from the illustration, but the following few dimensions will be of interest in this respect: the outside diameter of flywheel is 16ft.; mean diameter of armature—*i.e.*, diameter of pole centres—20ft.; overall diameter, 24ft.; width of armature strip, ¾in.; circumferential speed of armature at mean diameter, 9,800ft. per minute. The copper loss in the armature at full load is ·85 per cent.

This alternator has been running for about a month now, and has been tested with 75 per cent. of the full load on it. A neat method of indicating the relative speed of the machine before putting it into parallel with the others is in use. A series of white patches are painted on the rim of the flywheel, opposite alternator coils, Fig. 4. The arc lamp, which can also be seen in the same figure, is then supplied from the other source of alternating currents. As is well known, the light given off by an alternating arc is not continuous, but fluctuates with the alternations. Hence, when looking at an object lighted in this way, a series of consecutive impressions is received on the retina. So, when observing

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the white patches referred to, one really sees their positions at successive definite points on the current curve of the other alternator. If the two machines are absolutely in synchronism, the result is that the spots appear stationary. If there is a difference of speed, they seem to advance or recede according as to which machine goes faster. In this way the driver get a good indication as to whether his engine is at the right speed before the usual synchroniser is switched in.

It is a great pleasure to note that under the able supervision of the energetic engineer, Mr. D'Alton, the Deptford station is gaining load rapidly, so that additional machines are required. The regularity of the service, in spite of the transmission difficulties, is now justifying the original designs on which the station was projected, and the adoption of large units of plant has been supported strongly by the Continental firms. The actual output on Monday, November 18, reached the high figure of 13,000 Board of Trade units.

THE STONE SYSTEM OF LIGHTING RAILWAY CARRIAGES.

A new system of train-lighting, invented by Mr. A. B. Gill, has been taken up and developed by Messrs. J. Stone and Co., of Deptford. The London, Tilbury, and Southend Railway Company have had three trains fitted out on this system, after kindly allowing the inventor to experiment largely on a few coaches in order to test the new gear.

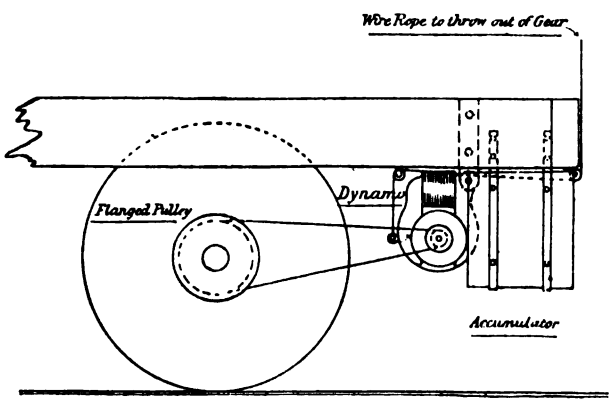

FIG. 1.

The main principle of this apparatus is exceedingly simple, and can be gathered from our illustrations (Figs. 1 and 2). A dynamo and a set of accumulators are provided on each coach, so that each is self-contained, and the train can be uncoupled without any alterations to the connections. The dynamo is hung on an axis under the carriage, and the necessary tension in the driving belt is obtained by the action of the weight of the machine. Unfortunately, this is not so clearly shown as might be wished in the diagram, Fig. 1, as when the machine is in the position there indicated the belt would have much more slack in it.

When the train starts, the dynamo, being geared by a link belt to the pulley on the carriage axle, gains in speed up to a certain predetermined value. Then a governor on the shaft completes, first, the shunt circuit, and then the main circuit of the dynamo, thus connecting it to the batteries and lamps. Now the automatic regulation begins. The machine is so balanced by a counterweight that the weight of the machine gives sufficient tension on the belt at that speed as to allow of a torque being given to the pulley corresponding to the required current in the dynamo. An increase in the speed of the dynamo would then mean increased torque, and this would move the dynamo towards the driving axle. But this movement would slacken the belt, and hence practically prevent an increased torque being given. As a result the belt slips, and the arrangement gives a constant speed as long as the current is constant. This device works exceedingly well, as far as could be judged from the carriages viewed on Wednesday last; but this problem in slipping belts is too new a feature to be approved without question. The dynamos are arranged to run at a constant speed corresponding to about 10 miles per hour, and then the belt speed is about 380ft. per minute. Hence at 50 miles an hour the belt is sliding on the pulley of the dynamo at four times this speed, or 1,520ft. per minute. Unless there is some new explanation as to the mechanical losses from slipping belts, we should conclude that at this speed the power taken from the axle of the carriage is five times that used by the dynamo. The pulley would hence be expected to get hot, but the cooling action of the air on the belt prevents this, as after a 20-mile run the hand can be held on the dynamo pulley.

The following are a few details of the system as applied to the carriages on the Tilbury line which carried the guests of Messrs. J. Stone and Co. to Grays and back on Wednesday last. The dynamo developed 25 amperes at a pressure of about 18 volts, of which current the lamps took 15 amperes. The remaining current passed into the accumulators, which keep the lamps alight when the train is standing. The eight accumulators are made by the Electrical Power Storage Company, and are of their E.K. type.

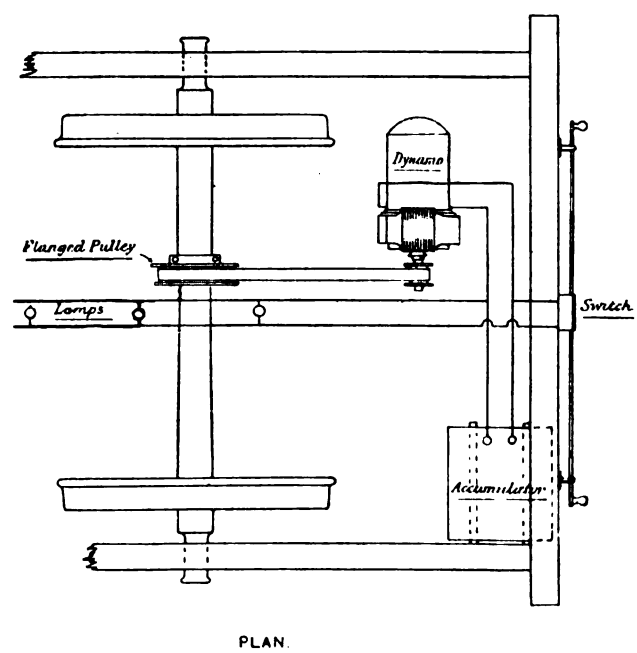

FIG. 2.

Their capacity is sufficient to keep the whole of the lamps in the carriage alight for four hours. The 16-volt lamps are arranged two in each carriage, and on different circuits, so that one half of the lamps can be switched off during long stops if it is desired to spare the accumulators. When the dynamo charges the accumulators, a resistance is automatically introduced in the lamp circuit. An accurately-made metallic cover is fitted to each machine, so that the working parts are kept perfectly free from grit and dust. This provision, combined with the fact that the capacity of the plant is ample for all requirements, reduces the wear and tear.

After the machinery had been viewed, the makers entertained their guests at the Holborn Restaurant. After the dinner and the usual loyal toasts, speeches of a most complimentary nature were delivered. Mr. A. B. Gill and the maker were congratulated on their new venture, which is already on trial on 18 different lines. The cost per carriage per outfit was stated to be about £50, but in the cost of upkeep a great saving is claimed over gas or even oil.

PHASE AND FREQUENCY TRANSFORMATION.*

A patent has been issued to Prof. Henry A. Rowland on a method of varying the frequency and number of phases of polyphase currents. The object of the invention is

* From the *Electrical World* (New York).

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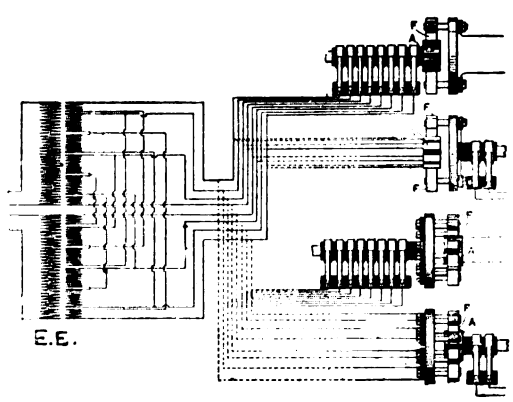
stated to be to vary the frequency of polyphase currents from zero to any desired frequency; to produce means for starting synchronous and other motors and causing them to run at different speeds, and to accomplish with other translating devices a variety of results of like nature. This object is attained by means of the combination with a commutator, either stationary or revolving, of brushes, which also may be either revolving or stationary. The bars of the commutator are joined by conductors to the source of electricity, either directly or by means of contact rings or brushes, and the current is carried from the commutator by brushes, either fixed or revolving independently of the commutator; or the current may enter by brushes and be carried off by the commutator brushes. Currents may be taken directly from the brushes or commutator bars when they are stationary, or through contact rings or other brushes when revolving.

In the accompanying diagram four different methods described in the patent are illustrated. The transformers to the left are for connection with a two-phased system, and are each wound with six secondary coils, the length of the coils and the connections being so arranged as to produce an eight-phased system. The upper device to the right represents a revolving commutator and fixed brushes, the conductor leading directly from the brushes to the contact brushes of the motor or dynamo. The device below differs from this in having the commutator stationary and the brushes revolving. The third device shows a lead of conductors somewhat different from the upper one, while the lower one shows a lead somewhat different from the construction given in the second device.



A continuous current will be carried off by the pairs of conductors to the right in the diagram, provided the corresponding devices run in synchronism with the current, while an alternating current will be carried off at any other relative speed, the polyphased current from the transformer being converted into a continuous or alternating current by means of the commutator, A, and the brush, F, either or both of which may be made to revolve. The speed of the commutator necessary to produce continuous currents can be reduced one-half, one-third, etc., by making the number of the commutator bars two, three, etc., times the number of wires from the transformer. By means of the arrangement shown, therefore, it is possible to transform an alternating current of any number of phases or frequency to another alternating current of any desired number of phases or frequency, and to further change these latter currents, either into a continuous current or alternating current of a greater or less number of phases or frequency, and to run a synchronous or induction motor at any desired speed, to start the same under any load, and to accomplish many other results that would readily suggest themselves to a skilled electrician.

While objections to the system may occur to some, such as relate to sparking at the commutator, and practical means for securing the necessary invariable rotary speed of the commutator or brushes with relation to the periodicity of one or the other circuit, these may well await the appearance of an apparatus in a practical form. The method, if commercially applicable, will be one of such great value that it is sincerely to be hoped that we may soon hear of its having been put in shape to be submitted to test in actual industrial work.

THE BURNING OF MESSRS. CROMPTON'S WORKS AT CHELMSFORD.

As all the world knows, the greater portion of the Arc Works at Chelmsford, belonging to Messrs. Crompton and Co., was burned to the ground on the morning of Friday last. The fire was first noticed at twenty minutes to nine, while the workmen were at breakfast, and within two hours damage was done to the extent of £50,000 or £60,000. The origin or the cause of the conflagration is unknown. It was at first thought that the new switchboard was the source of the outbreak, but Mr. Crompton has since stated that this could not have been the case. We paid a visit to the scene of desolation on Tuesday. The shops totally destroyed were the machine-shop with the engines, the armature-shop, and the transformer-shop; those saved from the flames were the lamp-shop, the boiler-house, and the smithy. The gutted portion of the works presented to the gaze a confused mass of fallen brickwork, twisted girders, and rusty and broken engines, dynamos, and other machinery.

One thing is certain—the flames spread with terrible rapidity, probably owing to the woodwork used in the construction of the buildings; and the men had not even time to bring the fire appliances of the works into operation. A curious feature of the disastrous conflagration was that the only heavy-tool part of the establishment that was unravaged by the fire was the little original or nucleus building of the works. A very severe loss is that of all the gauges, templets, standard measuring instruments, and drawings belonging to the company. Some of the workmen, too, have lost valuable tools. Fortunately, a year ago the accountancy department was removed to the London offices, and the chief business books of the company were therefore not at Chelmsford. Some newly-erected sheds, which were untouched by the fire, and which were to have been used for the manufacture of electric heating and cooking apparatus, will now be utilised for armature winding and other work.

At the time of the fire Messrs. Crompton were very busy, and were turning out on an average 130 arc lamps weekly. Some 650 men were employed at the Arc Works, and of these on Tuesday about 300 had been re-engaged, mostly for the barely-scathed lamp-room. On that day there was only a semi-portable engine at the works supplying power for the lamps; but there were three temporary or improvised stations—one in a field close to—deriving power from traction engines. The town of Chelmsford, which, unless we mistake, was the first in England to adopt public electric lighting, possesses two or three and twenty street arc lamps and about 13 miles of street incandescent electric lighting, nearly the whole of which Mr. Crompton expected to have running on Tuesday evening. Work in progress to the value of from £20,000 to £25,000 was destroyed, and the portion of the works and its contents ruined was insured for about £48,000. Amongst others, the company received friendly offers of aid from Messrs. Siemens, the Brush Company, the Electric Construction Corporation, Messrs. Marshall, Messrs. Scott and Mountain, and Messrs. Mather and Platt.

The local fire brigade performed very efficiently the work of combating and confining the area of the outbreak. In this arduous undertaking the borough surveyor of Chelmsford (Mr. Sasse) played a prominent part. He had a narrow escape of being badly hurt. He was standing near a large steam-pipe when it fell and burst, carrying away the upper portion of his hat and dashing him against a wall. This was practically the only casualty. Reverting to the question of the origin of the conflagration, Mr. Crompton states that he examined and passed the switchboard shortly before the outbreak, that the usual precautions were taken with regard to the switchboard, that there was no arc formed, and that the weight of evidence is against the switchboard having had anything to do with the fire.

A considerably exaggerated account of the damage caused by the fire having appeared in the local papers, Mr. Crompton has published a letter, in which he says: "Although the loss is serious enough, a considerable part of the works

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remains intact, and we are still in a position to execute orders for our lighter goods, and we hope to be able to carry out our orders for heavy goods in a few weeks' time."

Messrs. Crompton have since informed us that the electrical heating and cooking department is not affected, as their London works are alone employed in the manufacture of the apparatus.

NEW PARLIAMENTARY BILLS.

In the ensuing session of Parliament the following local authorities and companies are applying for provisional orders under the Electric Lighting Acts—viz, the Bournemouth Gas and Water Company; Bexhill Water and Gas Company; Guildford Gaslight and Coke Company; Wells (Somerset) Corporation; Bath Urban Sanitary Authority; Newington Vestry; Devonport Corporation; Vestry of the Parish of St. Mary, Battersea; Ilfracombe Gas Company; Midland Railway Company, seek powers to lay mains; Urban District Council of Colwyn Bay and Colwyn; Newmarket Electric Light Company; County of London and Brush Provincial Electric Lighting Company, for powers within the district of St. Saviour's District Board of Works, the parish of St. Mary (Newington), the parish of St. Giles (Camberwell), and the parish of St. Mary (Battersea); Merthyr Tydfil, J. C. Howell, Limited; Liverpool District Lighting Company, for powers within the districts of Allerton, Woolton, Childwall, and Garston; Kettering Urban District Council; Windermere and District Electricity Supply Company, for powers within the district of the Ambleside Urban District Council; Gloucester Corporation; Margate Corporation; County of London and Brush Provincial Electric Lighting Company, for powers within the county of the city of Lincoln; Urban District Council of Sale, in the county of Chester; London and Brush Provincial Electric Lighting Company, Limited, for powers within the borough of Ipswich; Bedford Electric Light Company, Limited, seek powers to produce and supply electricity for lighting and other purposes within the parishes of Great Berkhamsted and Northchurch, Hertford; Folkestone Corporation; Liverpool District Lighting Company, Limited, seek powers to supply electricity for lighting and other purposes within the districts of Great Crosby and Waterloo-with-Seaforth, Lancaster; Bangor Corporation; British Insulated Wire Company, Limited, Prescot, powers within the district of Huyton-with-Roby, also parishes of Whiston, Rainhill, and Eccleston; Darlington Corporation, purchase of land for electric light works.

The following seek powers to construct tramways or railways to be worked electrically—viz., Baker-street and Waterloo Railway Company, with electricity or cable power; London County Council, animal or electrical power; Portsmouth Street Tramways Company; South-Eastern Metropolitan Tramways Company; Kidderminster and Stourport Electric Tramway, powers to incorporate a company, to construct tramways, and work same with electrical or mechanical motive power; London United Tramways, Limited; County of London and Brush Provincial Electric Lighting Company, Limited, powers to construct tramways within the city and county of Lincoln; Sheffield Corporation; Huddersfield Corporation, powers to construct tramways in the borough to be worked by steam, animal, electricity, or other power; Blackpool and Fleetwood Tramroads, powers to incorporate a company to construct tramways and other works in the county of Lancaster, to be worked electrically or otherwise; Blackpool Corporation, powers to construct tramways in the parish of Bispham and to work them by electricity or other means; Derby and Ashbourne Tramways, powers to incorporate a company to construct tramways from Derby to Ashbourne and work same by electrical or other motive power; Sheffield District and Rotherham Tramways, powers to incorporate a company for the purpose of constructing and acquiring tramways and to work such tramways by electrical or other power; Oldham, Ashton-under-Lyne, Hyde, and District Electric Tramways, powers to incorporate a company for the purpose of constructing street tramways in the borough of Ashton-under-Lyne; Sheffield Corporation, powers as to construction, leasing, etc., of tramways and working them by electrical or other power; Swansea Corporation, powers to purchase the undertaking of Swansea Tramways and Improvement Company, and to erect generating stations for working trams by electricity; Halifax and District Tramways, powers to incorporate a company for purpose of constructing tramways and working them by electricity or other power; Brighton and Rottingdean Seashore Electric Tramroad Company, extension of time to complete works, etc.

WATCHES.

With the rapid developments of electrical enterprise, especially with regard to traction work to be expected in the near future, may also be expected a corresponding increased demand on the part of the public for reliable non-magnetisable watches. Many have been the complaints with regard to watches from the various localities in which electric railways have already been installed; but all this would soon be stopped if the public, when in need of new watches, took care to provide themselves with non-magnetisable ones. Messrs. S. Smith and Sons, 9, Strand, W.C., have made the manufacture of such watches a speciality, and are now producing them in great variety, differing in no wise, as far as external appearances go, to ordinary watches. Messrs. Smith and Sons, by the use of an alloy of palladium for the parts hitherto of steel, have been able to produce a non-magnetisable watch which has obtained the highest, or Class "A," certificate at Kew. Watches made by the same firm have also successfully passed through a severe test at the hands of the Admiralty. Another of Messrs. Smith and Sons' specialities is the split-seconds chronograph, with 60-minute recorder, of which they are the sole makers.

This chrongraph, which we illustrate herewith, has been specially designed for the use of electricians, engineers, cyclists, and others, and is also non-magnetisable. It will be found extremely useful by electrical engineers, to whom a reliable non-magnetic watch is an indispensable adjunct. Besides the manufacture of watches, the above firm do a large business in the conversion of ordinary watches into non-magnetisable ones, which, as will readily be understood from what has already been said, is a comparatively easy matter.

WHAT, WHEN, AND WHERE.

Institution of Junior Engineers.

December 6, 8 p.m.—At the Westminster Palace Hotel. Paper on "Considerations with respect to Water, Gas, and Electric Mains, etc, in Connection with the Formation of Urban Roads and Footways," by J. Julian, of the borough engineer's office, Cambridge.

Society of Arts.

December 2, 9, and 16, 8 p.m.—Three Cantor lectures on "Mechanical Road Carriages," by W. Worby Beaumont.

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INSTITUTION OF ELECTRICAL ENGINEERS, Nov. 28.

MR. R. E. B. CROMPTON (President) in the chair.

At last night's meeting of the Institution the following paper was read:

THE ELECTRIC WIRING QUESTION.

BY FRED. BATHURST, ASSOCIATE.

The "electric wiring question," which is the subject I venture to bring before you to-night, is one in which each individual member of the electrical profession has directly or indirectly more than a momentary interest. Moreover, in view of the contemplated issue of a new set of "wiring rules" which will bear the imprimatur of this Institution, it is at the present moment worthy of careful consideration. With the information and experience which has been accumulated in the past 12 years, we should now be in a position to lay down rules which will advance the art of wiring towards perfection. Such rules should not only conserve the welfare of the public, but should also regard the interests of the electrical industry. My object is to ask that, in any consideration of this question, due recognition may be given to the use of an insulating tube as one of the factors which must enter into the question of perfect wiring. Hitherto the ordinances issued in respect to wiring have had for their primary object the prevention of fire, and have therefore received the general designation of "fire rules." These rules have been rigorously administered under capable, indefatigable, and impartial inspectors connected with the various fire insurance offices. No question can be made as to their efficacy in respect to the prevention of fire, but I submit that, considered from a technical and economical standpoint, they cannot in any way be regarded as ultimate or final. It could be argued with much reason that, from the fact of their having specified definite means and methods under which wiring should be effected, we have even been led to expend our energies in directions which do not truly advance us towards the goal we seek. Electricity, in respect to its utilisation, should not be tied down to specified lines and methods which hamper its proper development and progress.

THE DEVELOPMENT AND GROWTH OF WIRING.

The electric light, from sheer force of merit, has forced its way into recognition as a luxury, and the public now willingly admit that it is an accessory to their comfort and convenience. Perhaps I may be pardoned a momentary digression to outline briefly the electrical progress of England as compared with some other country. Let us take the country typical of progress—America (see Appendix A). Both countries were in 1881 on the same basis; the apparatus was crude, experimental, and imperfect, and the knowledge in respect to the safe and proper handling of the apparatus employed was limited, and possessed by but few people. In England in 1883 the possible dangers began to attract attention, and rules and regulations were issued which were to control development and progress. In America no regulations were enforced; for good or evil, a normal development held its course. The American knew his imperfection, but his utilitarian instinct forced him to employ any means at hand by which to gain further experience. Oftentimes absolute security may have been sacrificed to the necessity of the moment. The American public, however, demanded the new light, and it had to be installed at prices which did not always provide for solidity and permanence. That it was sufficiently satisfactory for acceptance cannot be questioned, since in 1887 they had in operation (not to mention innumerable isolated plants) some 70 central stations, supplying over a quarter of a million incandescent lamps. In England at this time there was one central station, supplying about 5,000 lamps, and a proportionate number of independent plants.

It is just here that insurance authorities may ask about electrically-caused fires. If so, I seize the opportunity for removing what appears to be a greatly exaggerated apprehension. The hurriedly installed apparatus did cause fires, and in a measure terrorised the public much in the same way as our recent subway explosions in London alarmed the British public. Gradually, also, the American fire insurance offices took alarm, and "rules" began to see light. Different States had different regulations, and each inspector became a "law unto himself." Ultimately, it was seen that "confusion had become worse confused," and that effort must be made to produce rules which would be generally acceptable. Within the last few years the underwriters determined to appoint an electrical bureau to collect information concerning the fires said to be "caused by electricity," in order that some general deductions could be made. The reports issued by the bureau (under the effective direction of Mr. W. H. Merill, jun.) are most comprehensive, and give valuable and instructive information in respect to the electrical fire hazard. Taking 1893-1894 as two typical years in which public alarm was prevalent in America, reference to the records shows the occurrence yearly of between 400 and 500 fires traced to electrical causes. Some 320 involve no monetary loss, but the remainder (100 to 200) result in a loss of £300,000 per year. This sum, though apparently large in itself, is less than 1 per cent. of the total fire loss of some £35,000,000 from all causes. The bulk of the electrical loss occurs in the Western States, and for the more populous eastern towns the proportionate loss is less than ½ per cent. The loss arising from the use of kerosene oil and matches is appalling in comparison, and the figures are best not quoted. In fact, the insignificance of the danger from commercial electrical application is best shown by comparison with the loss caused by Nature's wayward electrical illumination—lightning. Taking the figures from the United States Government records, I find, from the average monetary loss per year, for nine years ending 1893, that "lightning" involves a loss of £310,000, or some £10,000 per year more than that caused by the commercial use of electricity. It can therefore, I think, be affirmed that in the country where electrical progress has been least restrained by artificial regulation, the loss on account of the electrical fire hazard is not so formidable as usually supposed. At the present time America has the benefit of numberless motor applications, and over 8,000,000 arc and incandescent lamps, against, perhaps, 2,500,000 in England. Can I not, therefore, argue that restrictions of one sort or another have hampered the proper development of our electrical industry? And, again, is it not a matter of everyday comment with us that the electrical profession, working under the present conditions, does not reap to the full extent the benefit which should accrue to its work?

Returning to our retrospect, we find, however, that, technically considered, we are no longer in the same position as in 1881. Electrical apparatus in every detail has been the subject of patient improvement. Switches have developed from flimsy, poorly-designed mechanisms on wooden bases to substantial metal and earthenware constructions, which are fireproof, and electrically and mechanically perfect. Lampholders, once three-prong wooden devices, fitted with spiral spring contacts, have developed to the present finished type. The insulation on the wires has changed from paraffined cotton to a durable rubber covering. Not only has the quality of material been enhanced many times, but with it market values have fallen so as to be on something like a permanent basis. Central supply stations have been built, and methods of generation and distribution so improved that electricity can be supplied, light for light, at prices directly comparable with gas. Up to the consumer's premises we have economical electrical production and distribution, and, notwithstanding the expense of the initial installation within the house, a demand for the light has grown. The recent rapid growth of municipally-owned electric supply stations would even prove that it is becoming an actual necessity. Why, then, is it that in England, the most prosperous country of the world, this light—the safest and best illuminant—is not making the same rapid headway and progress that it is doing amongst less favoured nations? This, in fact, is the "burning question," which I shall endeavour to make as important as that "question of burning" of the fire insurance companies. Even if it is contended that we are, as a whole, making sufficiently rapid commercial progress, no one will dispute the statement that, commercially considered, the state of affairs with our "wiring contractors" is, to say the least, bitterly disappointing. The bare mention of the fact that for the same piece of work tenders may be received which vary in respect to one another by 100, 200, or even 300 per cent., is in itself sufficient to show the conditions obtaining in this direction.

THE PRESENT PROBLEM.

The principal obstacle to the general use of electrical applications is that under our present wiring rules it is impossible to place the cost of installation within reach of the great bulk of our people. The largest number of consumers to whom we cater—the middle class—cannot afford the initial outlay necessitated by adherence to our present methods. The introduction of electric lighting has educated them to the point of desiring better and more light, but we still have a further duty to perform in bringing this advantage within their means. I submit, therefore, that what is still required is the introduction of rules and regulations which will facilitate the growth of "lower cost wiring." If the term "cheap wiring" is used in this connection, by implication, such work will be termed "nasty." Nothing is further from my intention than to advocate cheap, defective, poor, or dangerous wiring. But, speaking as one whose wish is to promote the welfare of our industry, I suggest that the time has arrived when the advent of "wiring methods" which will reduce the first cost of electrical installation to the general public by perhaps one-half that now obtaining, will, if rightly ordered, give to electrical activity, with its inherent possibilities, that impetus which we all know it to be capable of receiving. With "lower cost" wiring we could, for instance, successfully compete with the lately introduced "incandescent gas burner," which, priced at about 13s., has had a sale amounting to three-quarters of a million. It is being recognised that the ruling factor which governs public demand is small initial outlay. Even the gas companies are facing the question of fitting consumers' premises free, and

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reimbursing themselves by charging a slightly increased price for the gas supplied.

The Technical Requirements.

Having established the fact that, either from "excess of supply" or a "lack in demand," our contractors are face to face with a serious economic problem, it behoves us to look into our present methods of wiring, to see in which direction economic improvement can be contemplated. Let us consider briefly the essential features of good wiring. The five cardinal points may be given as safety, durability, convenience, accessibility, and economy. Prof. S. P. Thompson, in a lecture on the subject before the Society of Arts, has embodied the essential features in a few words when he said, "What is wanted is a mode of running wires and fixing switches and other accessories so that they shall not only be electric-tight, but shall also be water-tight, gas-tight, air-tight, oil-tight, fire-tight, and even rat-tight." The only "tight" he has omitted is "money-tight." It is my belief that all these requirements can be met by the use of fireproof insulating tubes; but before dealing with this point I may be permitted to challenge the existing methods in the light of these requirements. As the advocates of "concentric wiring methods" are, I understand, to present their views, courtesy leads me to avoid any direct criticism of "concentric" systems, except under those general headings in which they could obviously be included.

Present Methods in the Light of the Requirements.

It will probably be admitted that wood casing fails in many respects. As a "mechanical" protection for the wires it is imperfect, and it is as deficient in "insulating" protection, because it is neither damp-proof nor incombustible. To again quote the words of the above referred to authority, it may also, like charity, "cover a multitude of sins." In concealed work it is positively an obstacle to the development of electric wiring. It shrinks and warps, causing plaster to crack, and often necessitates costly redecoration. The idea of its use originated with the telegraphic engineer, and 15 years ago electricians were contented with it. Then it served the sufficiency of the moment. On account of its one desirable attribute—accessibility—it may survive somewhat longer for surface work. Even on the surface, however, it is neither picturesque nor decorative. It is easy to instal, but its nature prevents any very correct or exact estimate being formed of the labour required. If surface work is required on the score of economy, surely it would be better to adopt "open work" on porcelain insulators—a safe and scientific method of wiring, which can be carried out at a very much lower price. We know this system is discouraged; but it is noteworthy that in the only prominent installation in this country where "open work" has been used, the single source of trouble which occurred arose on a circuit in a damp cellar, where, in order to conform with the fire office "requirements," wood casing had been employed. Someone may argue that this could not have occurred if the circuits had been "tested" as the "rules" recommend. This statement I will answer by a question. It is, whether "insulation resistance" as now specified is not, after all, somewhat of a myth? (see Appendix B). Our "insulation test" never yet told far into the future, and it only tells the present to a limited extent. "Insulation test" cannot discover an unsoldered joint or a dangerous diminution in respect to current-carrying capacity. Every practical man will agree that insulation testing will not necessarily indicate that the wires are at places in dangerous proximity to gas or water systems in event of moisture appearing.

To continue, the recognised shortcoming of wood has brought into use iron and "lead-compo" piping. Lead-compo pipes afford but little mechanical protection in emergency, and, with respect to "accessibility," have serious drawbacks on account of their flexibility. A large amount of "surface leakage" necessarily arises from the use of any ordinary metal tubing. Moreover, if the insulating material on the conductors has from any reason deteriorated and moisture appears, there will be consequent injury both to conductor and tube. Cases have occurred where the protecting fuses on a circuit did not "blow" before electrolysis promoted a dangerous arc which had burnt a hole in the tube and presented a serious fire risk. If a defect occurs anywhere in the insulation of a wire which is within a metal pipe so that there is electrical contact between the conductor and the pipe, the effect of the fault is virtually transmitted throughout the whole length of piping, there to await or invite trouble elsewhere. With two conductors in the pipe a new and unanticipated electrical condition prevails, because one conductor is now of greater carrying capacity than the other, which has been increased by the capacity of the tube itself. Overheating of the intact conductor can now invite serious trouble at any point. This, I think, explains why overloaded wires in pipes have occasionally "burnt out" at several points at the same instant. It must not be forgotten, also, that failure of insulation on one wire means that the voltage tending to break down the other is doubled, and the actual strain (C^2R) increased fourfold.

Perhaps at this point, already, it will be noticed that my criticisms show, incidentally, how much more our immunity from electrical fires has depended upon the honour and integrity of our contractors than upon the "rules" provided for their guidance. Iron pipes have the disadvantages common to all metal pipes, and, as we know, may rust inside, and this rust is not a condition favourable to "insulation"; they often have burrs or other internal roughnesses which may cause serious mechanical damage to the insulating material as the wires are being drawn in. If iron pipes are screwed at the end for the purpose of jointing, oil is probably employed, and any excessive presence inside is not helpful to a rubber insulation. Cases are on record where this oil has caused extensive mischief. Early in the art of wiring it was recognised that gas-brackets, when modified so as to serve as "electrics," should be insulated from the remainder of the gas-piping; but now that we are using electric wires themselves in metallic pipes, we appear to overlook the possibility of the electric system being elsewhere in hazardous contact with conjointly installed steam or water systems. It is now apparent that metal pipes, if not actually harmful, are certainly not particularly helpful to the maintenance of insulation resistance.

As thrifty business men, we must recognise that when buying electric wires we are paying for insulation. It is true we require the copper for current-carrying capacity, but in a high-grade wire the expense of the insulation is about twice that of the copper. From the commercial aspect, apart from any technical considerations, the cost of a metal pipe is a formidable drawback. The usual clause dealing with the protection of "conductors" says "they must be enclosed in substantial wood casing or approved metal tubes." If this refers to iron or compo pipe, and we are to adhere to the regulation, how can we compete with the gasfitter when we have to supply the pipe as well as the insulated wires inside it?

The Advantage of Tube or Conduit Methods.

It may be thought that we must turn away from tube or pipe methods altogether in order to find economic wiring. Experience in other countries, however, does not show that any "rigid" system of conductors is making progress or headway. No insulated wire has yet been produced which in itself can successfully resist the deteriorating influences present in mortar or plaster. Even lead-covered insulating wires, if directly embedded in plaster, have been found wanting, and give trouble from "earths" and "short-circuits" as soon as moisture has made an appearance. With any rigid method, if walls happen to crack and settle, or plasterers and bricklayers cause damage, a fault may develop which is very difficult to find. Usually, also, they are handicapped commercially in respect to making joints and connections, as these involve risk and trouble even with the highest-quality workmen. A cardinal objection to "rigid" methods is the lack of accessibility. All good wiring should be accessible, for with this quality assured half the difficulty of "trouble" is already fought, and any imperfection or injury, whether arising from poor work, negligence, or accident, can be remedied with a minimun of inconvenience. A conduit or race-way is the practical way of rendering wires "accessible," for then the wires installed in them are always open to the inspection of owner or wireman, whenever he wishes to satisfy himself as to their condition or to effect a renewal. "Accessibility" ought, therefore, to be a fire office requirement (see Appendix C); with it an inspector can use his eyes and have no need to trust to his ears for inspection. From the contractor's point of view "accessibility" is desirable as limiting unfair and injurious competition; for when an installation can be readily inspected, inferior materials cannot be used for the purposes of cutting down prices, workmanship cannot be scamped, and the "death knell" of unprincipled competition could be sounded for all time.

The Superiority of an Insulating Tube.

This brings us to the consideration of the conduit itself. From a labour-saving point of view a flexible conduit would apparently commend itself. Whilst cases do occur where this is true, every flexible conduit has the inherent drawback, as shown by experience, that the property of "flexibility" may so far assert itself that numberless bends will prevent the wires from being drawn out. Any trouble which then occurs will have to be cut out, or else the circuit must be abandoned or wired anew. Flexible conduits are always at a disadvantage either in respect to moisture-resisting properties, or are wanting in mechanical strength. Bends and elbows must be rigid, or it is impossible to draw the wires in or out; and for the generality of work it will be found that a conduit construction permanently rigid throughout is preferable. I have already pointed out that more than half of the cost of the wire we use is referable to "insulation," and that it is "insulation" we strive to keep. It would, therefore, appear obvious that the conduit should be an "insulating" one. An ideal insulating tube should not only be mechanically strong, but also fireproof and waterproof.

(To be continued.)

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THE CONFERENCE.

No doubt the late conference will provide texts for many sermons. One clause was warmly debated, and in the end a compromise was made. We refer to Clause 27, which reads that "all conduits, pipes, or casings used as receptacles for electric light lines shall be constructed of durable material and of ample strength to prevent damage from heavy traffic, and when they are laid in streets in which gas-mains are also laid shall be so constructed so as to prevent any influx of gas from the adjacent soil." We shall not recapitulate the discussion to be found reported in another column, but desire to press home strongly the views that must be predominant amongst electrical engineers. No one objects to take all reasonable precautions. They would, in fact, be taken without any Board of Trade regulations at all. The desire of an electrical engineer is to place his wires in street or conduit, and after once placing them to have as little knowledge of their position as possible. Every time his attention is called to his mains it probably means something wrong—annoyance of customers and spending of money. He would be glad to know of some absolutely safe arrangement from faults and troubles. That is—and we have put it very feebly—his position. But what is the position of his partner underground—the distributor of gas? There never has been, so far as we know, any compulsion upon the gas distributor to prevent leakage. From the earliest times of gas distribution to the present it has been known that leakage was more or less constant. It is known that generally the soil around gas-mains is tainted with the leakage from those mains. No particular harm arises while the earth is the receptacle of the leakage — rather the contrary, for up to a certain point such leakage may act as a disinfectant; but if any cavities exist within the area of leakage, into which cavities the gas can penetrate, then the danger of an explosion arises. We may tolerate the stink in the soil, but we cannot tolerate the danger of explosions. Two things seem to be required to obtain the dangerous state—first, the leakage; secondly, the cavity. It would be a monstrous injustice to electrical engineers to compel them to render every cavity gas-tight, when no effort was made to compel gas engineers to render their mains gas-tight. We are inclined to say the latter is by no means a simple operation, while the former is an impossible one under the ordinary conditions that obtain in most large towns. The best possible way out of the difficulty is in the nature of a compromise in which neither party is to be compelled to do the impossible, but that each party is to be compelled to take every precaution, and by constant supervision render an accumulation of gas difficult. We speak under correction, but, according to our knowledge, gas-mains cannot be rendered gas-tight so long as they are made of the material usually employed—viz., cast iron. Similarly, using the ordinary materials for conduits and channels, these cannot be made gas-tight; and so long as there can be a mixture of gas and air, so long there must be the danger of explosion. The simplest and most

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perfect method of avoiding the danger is by the "freest ventilation." There have been other considerations in the designing of conduits and street boxes than the fear of gas accumulation, and these considerations have undoubtedly played into the hands of gas. Receptacles of the prettiest and most convenient kind imaginable have been made by the score, and the wonder is, not that we have had troubles and explosions, but that we have had so few of them. The weight of evidence seems to point to some "spark" external to the manholes or conduits as usually the immediate cause of the explosion. Yet it must be confessed—and confessed with a considerable amount of shame—that bad workmanship has something to answer for in a few ignitions. You may have explosive mixtures in a cavity till Doomsday without explosion. The exciting cause must be something external to the gases, and, as we hint, an arc has more than once been this cause. Now, an arc at connections can be, and ought to be, avoided. If it exists, the connections are wrong. All this, however, has been said before, and is well known. We are merely trying to emphasise the desire which exists to saddle both parties—the distributors of gas and the distributors of electricity—with precautionary regulations. We thoroughly understand that the major portion of the industry would restrict the stringent regulation to transformer-chambers. We are in the minority, but that only means acquiescence in the views of the majority when the regulation is fixed and irrevocable. The Board of Trade has given full and fair discussion to these proposed revised regulations, and if after they come into force explosions occur at junction-boxes, manholes, or anywhere than transformer-chambers, public opinion will insist upon the most stringent regulations being made, without consulting the wish, the convenience, or the money interests of the profession. What all electrical engineers want is a truer perception of the old adage, "Prevention is better than cure." Too many of them are ready to put up an installation anywhere and anyhow for anything, perfectly indifferent to aught except they get their money for the work done. On every hand, even now, they are promising what they cannot perform, and what every disinterested observer knows must result in failure, instead of insisting that everything should be done in the most perfect manner possible. In our opinion, then, the regulations would better err by being too stringent than by being too lax.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE BOARD'S PROPOSED REGULATION ON TESTING ELECTRIC SUPPLY SYSTEMS.

SIR,—No one could have attended the meeting last week at the Westminster Town Hall on the question of the revision of the Board of Trade regulations for the public supply of electrical energy without admiring the ready way in which Sir Courtenay Boyle accommodated his decisions to those objections of the conference which had been well considered, and to the strict views on each question that Major Cardew's position necessarily obliged him (as the adviser of the Department) to adopt.

On one point I venture to add to my remonstrance made at the time, and to ask you to allow me space in your pages to ventilate my views as to Rule No. 10, which prescribes weekly tests of what is called a "circuit." Eight years ago, when the rules, then drafted in the crudest form, were being considered by a committee of the Institution of Electrical Engineers, I objected to the word "circuit." My fears that it is a misplaced term as applied to systems of electrical distribution under statutory powers, were emphasised on the 19th inst., when Mr. Preece stood up and drew an analogy between the daily testing of telegraph circuits and the testing of electric lighting mains. The word "circuit," if it is rightly applied to such a system as the rules deal with, includes the most remote point with which the sources of supply are connected electrically, which means every conductor and fitting (lamp and electrical) inside the premises of every consumer, as well as the undertaker's mains and service lines under his control, up to the consumer's terminals.

I found it hard to believe my ears, and perhaps I misunderstood what I heard—that it is now proposed to require a weekly test of a whole distribution system, including in the test the wires, etc., in, say, 1,000 houses, and to consider the result thus obtained to have the smallest practical value for purposes of protecting the public or for securing efficient maintenance. I can only conclude that those who believe in it have had no experience, and that Mr. Preece forgot to tell the audience that the Post Office system of daily tests always, if possible, cuts out the loops and sections not maintained by the Department before a test is made.

Any practical engineer knows that one of the chief objects of periodical tests is to obtain a history of the behaviour of the insulation in sections of conductors of such an area as to reduce the labour of localisation should evidence of rapid deterioration or actual breakdown occur. Mr. Preece might just as well propose to his officers to bunch the whole of the circuits entering one large telegraph office in one test, and include in that test every section that might be on the railway company's poles, over the maintenance of which they have no control, and then expect them to arrive at any practical conclusion as to their condition, or as to the works of repair or renewal that is required.

I ventured at the meeting to suggest to the chairman that this most important question required very careful consideration, and that experience since the rules were first issued had grown considerably. My contention is that the condition under which various systems can make useful tests varies considerably. For instance, I believe not many have been laid down and arranged in separate transforming areas before work was commenced, as was the case of the city of London, described in my paper before the Institution in 1893. In such a case the facilities for testing are greater than in systems which began as straggling and pioneer in character, and which have never emancipated themselves from the effects of absence of forethought by those who designed them. I believe that very few undertakers have really carefully considered the best means of excluding their customers' systems from their periodical tests. As time goes on, and insulation deteriorates, it would be forced on them without any Board of Trade rules. Those who have looked ahead and considered it have, I am sure, a happier future before them.

Broadly, I suggest that the question bears an essentially different aspect in the case of those systems which have a large quantity of bare copper conductors and those in which the conductors are insulated throughout.

In my suggestion to the chairman I included one to the effect, that before any rule on the subject is issued the Board of Trade should call on the undertakers of all the well-established systems to report, describing what they have done, and the results, and what it suggests itself to them to do in the future; and this suggestion I am constrained, with your assistance, to press on the notice of the profession as the only way of getting it discussed.—Yours, etc.,

C. E. WEBBER.

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THE REVISED REGULATIONS OF THE BOARD OF TRADE.

(Concluded from page 599.)

II.—*Aerial Lines where Erected with the Necessary Consents.*

(16) Every aerial line shall be attached to supports at intervals not exceeding 200ft. where the direction of the line is straight, or 150ft. where this direction is curved, or where the line makes a horizontal angle at the point of support.

(17). Every support of aerial lines shall be of a durable material, and properly stayed against forces due to wind pressure, change of direction of the lines, or unequal lengths of span. The factor of safety for the lines and suspending wires shall be at least 6 and for all other parts of the structure at least 12, taking the maximum possible wind pressure at 50lb. per square foot. No addition need be made for a possible accumulation of snow. Every support, if of metal, shall be efficiently connected with earth.

(18) Aerial lines shall be attached to insulators, and shall be so guarded that they cannot fall away from the support. Conductors covered with insulating material shall not be attached to the insulators by metal binders.

London Chamber of Commerce.—The word "uninsulated" should be inserted before "metal binders."

The amendment of the London Chamber of Commerce to insert "uninsulated" was accepted.

(19) An aerial line shall not in any part thereof be at a less height from the ground than 18ft., or where it crosses a street 30ft. (in the county of London, 35ft.), or within 5ft. measured horizontally or 7ft. measured vertically from any building or erection other than a support for the line, except where brought into a building for the purpose of supply.

London County Council.—Eighteen feet, in line 2, should in London be 20ft. to correspond with the London Overhead Wires By-laws.

Barrow-in-Furness Corporation.—Having regard to passage of fire-escapes through streets, and the convenient placing of such escapes against buildings, consider that the minimum height of wires should be 21ft. Consider word "street" indefinite. Think word should be defined or that the clause should read "or where it crosses a street or road."

Dover Co. and County of London Co.—It should be made clear that this regulation does not apply to arc lighting, as in some cases the most efficient means of illuminating narrow streets is by suspension of arc lamps in the middle of the roadway, and the heights given are therefore excessive.

Ogmore Valley Co.—By Board of Trade consent, company are now allowed 20ft. in crossing streets and 2ft. distance from buildings. This suits the district much better than proposed regulation.

Lord Russell asked that the Board of Trade should make the exception desired by the county of London.

The **Chairman** thought it should be 20ft. and 35ft. in London and large boroughs, and 18ft. and 30ft. in special cases. There was nothing in the clause to prevent local authorities from making more stringent limitations.

(20) Service lines from aerial lines shall be led as directly as possible to insulators firmly attached to some portion of the consumer's premises which is not accessible to any person without the use of a ladder or other special appliance, and from this point of attachment they shall be enclosed and protected in accordance with the regulations hereinafter contained as to service lines on the consumer's premises. Every portion of any service line which is outside a building, but is within 7ft. from such building, shall be completely enclosed in stout indiarubber tubing.

London County Council.—The words "and kept enclosed" should be inserted in the last line but one.

Ogmore Valley Co.—Service lines to be enclosed within indiarubber tubing. Qy. necessary where undertakers use such low pressure as this company.

Phœnix Fire Office.—This might be slightly modified. Service lines are sometimes brought into roofs and other inaccessible places. It is most desirable that service lines should be brought into buildings to situations suitable for placing up the main cut-outs and switches in thoroughly safe and accessible places at the points of entrance.

Mr. Heaphy, referring to the amendment of the Phœnix Fire Office, said he had seen service lines brought into roofs and cut-outs placed there where they were almost inaccessible, and hence difficult of access in case of necessity. He strongly objected to the word inaccessible.

The **Chairman** said the Phœnix suggestion should be considered.

(21) When an aerial line crosses a street, the angle between such line and the direction of the street at the place of such crossing shall not be less than 60deg., and the spans shall be as short as possible.

(22) Where an aerial line crosses, or is in proximity to, any metallic substance, precautions shall be taken by the undertakers against the possibility of their line coming into contact with such metallic substance, or of such metallic substance coming into contact with their line by breakage or otherwise.

National Telephone Co.—Desire the addition of a clause providing that where wires carrying high tension currents cross over or under wires belonging to any other person or company, a guard wire must be provided at the expense of the owners of the high-tension wires, for the purpose of preventing the high-tension wires from getting into contact with the wires of such other person or company, and so causing destruction to property.

(23) Every high-pressure aerial line shall be efficiently suspended by means of insulating ligaments to suspending wires, so that the weight of the line does not produce any sensible stress in the direction of its length. All suspending wires, if of iron or steel, shall be galvanised.

Institution of Electrical Engineers.—Omit regulation entirely.

London Chamber of Commerce.—Old Clause 32 should be retained. "(32) Where any aerial conductor belonging to the undertakers is erected so as to cross any other aerial conductor or any suspended wire used for purposes other than the supply of energy, precautions shall be taken by the undertakers against the possibility of their conductor coming into contact with such other conductor or wire, or of such other conductor or wire coming into contact with their conductor by breakage or otherwise." This clause should be limited to wires, say above $\frac{1}{16}$.

Mr. Crompton said experience had shown that the clause would be injurious to the industry. Instead of suspending by ligaments, it was safer to make the cables self-supporting. The insulating ligaments were most unreliable, and also deteriorated the insulation of the cables.

The **Chairman** said it was a mechanical question. Suppose the cable broke, and fell.

Mr. Crompton said the tags were the most vulnerable point of the construction. It was always the suspending wire that broke.

Mr. Gunyon, for the London County Council, said he had heard no satisfactory reason for the proposed omission.

Mr. Crompton thought it was obviously better to make the cable self-sustaining, than to carry it by leather tags on a steel suspension wire. It became necessary to insulate the suspending wire, and, in fact, almost every part of such an arrangement defeated its own object.

The **Chairman** of the Taunton Electric Lighting Committee said they had used self-suspending cables of hard-drawn copper, and had suffered no inconvenience. He thought they should not be compelled to alter that.

Mr. Gunyon said a long length of self-sustaining cable might bring a strain on the insulation.

Mr. Crompton remarked that the insulating material was far more extensible than the copper. Mr. Gunyon's point was a purely academic one.

Major-General Webber said the regulation would be disastrous to the conveyance of power. Was it intended that there should be no bare copper overhead conductors used for high-tension currents?

The **Chairman** thought there must be special regulations. He would, however, remark that he had lately come from a large metropolis where there were no aerial lines at all.

Major-General Webber said he was not an advocate for them in towns, but there were many places in the country where the conditions of the clause would compel what was a mere waste of money.

(24) In the case of any aerial line exceeding one-half mile in total length, means shall be provided whereby the pressure may be discharged from any portion of such line erected over or alongside of any building or buildings without loss of time in case of fire or other emergency.

Institution of Electrical Engineers and Northern Society of Electrical Engineers.—Line 1: after word "any" insert words "high pressure."

This clause passed without debate, the amendment of the Institution of Electrical Engineers to insert "high pressure" in Clause 24 being accepted.

(25) Every aerial line, including its supports and all the structural parts and electrical appliances and devices belonging to or connected with such line, shall be duly and efficiently supervised and maintained as regards both electrical and mechanical conditions.

(26) An aerial line shall not be permitted to remain erected after it has ceased to be used for the supply of energy, unless the undertakers intend within a reasonable time again to take it into use.

III.—*Electric Lines other than Aerial Lines.*

(27) All conduits, pipes, or casings used as receptacles for electric lines shall be constructed of durable material

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and of ample strength to prevent damage from heavy traffic, and where they are laid in streets in which gas-mains are also laid shall be so constructed so as to prevent any influx of gas from the adjacent soil.

Dublin Corporation.—The Corporation boxes are open at the bottom for drainage, and ventilation is provided for in the covers. Neither gas nor water has ever accumulated in them. If the Corporation have to prevent "access of gas" they will have to reconstruct all their boxes, and they doubt if the result would be more efficient.

Dover Co. and County of London Co.—Suggest addition of words "so far as possible" after "so constructed as to prevent."

Yorkshire House-to-House Co —Submit that use of a blower for keeping mains free from gas and water should be considered sufficient, without requiring prevention of influx by a special construction of conduits and boxes.

Islington Vestry.—Object to the requirement as to preventing an influx of gas into conduits. It will seriously increase the responsibility of undertakers, and put a powerful weapon of defence in the hands of gas companies.

Institution of Electrical Engineers.—Substitute for Regulations 27 and 35. "All conduits, pipes, street boxes, or casings used as receptacles for electric lines shall be constructed of durable material, and wherever they are laid under carriageways shall be of ample strength to prevent damage from heavy traffic; and reasonable means shall be taken by the undertakers to prevent accumulation of gas. The undertakers shall regularly inspect their street boxes for the presence of gas, and should any influx or accumulation be discovered, the undertakers are to give immediate notice to the gas authority." That undertakers should only be required to take precautions against accumulation of gas. That risks from explosions caused by influx of gas are very small save under very exceptional circumstances — such as the frost of last winter When so many gas mains are broken, as was then the case, it is impossible to prevent influx of gas to chambers underground. Suggest stricter enforcement of Gas Acts.

London Chamber of Commerce.—Old Clause 14 should be sufficient: "(14) All conduits for conductors constructed in streets in which gas-mains are also laid shall be efficiently protected against an accumulation of gas." Where any influx of gas from adjacent soil occurs to their knowledge, undertakers shall give notice to gas company and to Board of Trade The clause should not be operative in regard to existing conduits, etc. Gas companies should be put under restrictions preventing escape of gas, etc

Glasgow Corporation.—It is impossible so to construct culverts as to prevent an influx of gas. This part of clause should be omitted. Suggest that "all reasonable precautions shall be taken" should be substituted.

Charing Cross and Strand Company.—Appears to be impossible as regards prevention of influx of gas. Ventilation the only practicable remedy.

Portsmouth Corporation and Shoreditch Vestry.—Wish to emphasise as strongly as possible their disagreement. It would be quite impracticable to attempt to render conduits gas-tight. The gas companies should keep their mains gas tight, and the electric light undertakers should be required to ventilate conduits. Gas companies would make this regulation a point of defence for any damage that might accrue through gas leaking into conduits.

Westminster Co., Edinburgh Corporation, Aberdeen Corporation, Belfast Corporation, Oldham Corporation, and Sunderland Corporation.—That as gas companies are unable to prevent leakages of gas from their pipes, it is unreasonable to ask electrical undertakers to devise some way of keeping the gas out of their pipes and conduits, and that the only real remedy lies with the gas companies. Suggest that Clauses 27 and 35 be amalgamated, that they should provide that the electric light companies should take every reasonable means to prevent gas entering their pipes or casings, that the companies should subject these to periodical inspections (which might be specified), and that it should be their duty to report at once to the gas company any case in which gas was found to exist, and at the same time either to report to the Board of Trade or the sheriff or local authority if the gas leakage were not found and remedied by the gas company within a reasonable time A regulation such as this could be enforced and carried out, whereas the proposed regulations could not be carried out, and their existence as a dead letter might stand in the way of any reasonable steps being taken

Manchester Corporation.—Between "to" and "prevent" insert "as far as possible" It is practically impossible to construct any subterranean chamber which shall be absolutely gas-tight.

Northern Society of Electrical Engineers.—After "prevent" in line 5, insert "as far as possible."

Mr. Gay, in reference to Clause 27, said he was instructed by the Islington Vestry to press their amendment as hard as the Board of Trade would allow The regulation as it stood would place a very serious responsibilty on the undertakers. The latter used to be required simply to take "efficient measures," but now they were to be compelled to prevent any influx of gas. It might be quite possible by proper ventilation to prevent any serious accumulation of gas, but nearly everyone in the room would agree with him that it was not possible to keep any conduit system absolutely gastight. It might necessitate the expenditure of enormous sums of money if the regulation was made retrospective.

The **Chairman**: Would inserting "so far as possible" be sufficient?

Mr. Gay thought the burden placed upon them was unreasonable. If the gas companies could not keep their mains gas-tight, it was equally impossible for the undertakers to keep their conduits gas tight. The regulation would put a very powerful weapon into the hands of the gas companies, and the electric lighting companies would have to pay for the delinquencies of the gas companies. He (Mr. Gay) contended that electric companies ought not to be hampered on account of the faults of other large bodies, and urged the most serious consideration before the clause was passed.

Mr. Hammond remarked that he had always found it best that the street boxes should have no bottoms, so that all the land drainage could easily get away From his experience in Dublin where they had had no difficulty he should certainly support the amendment of the Institution of Electrical Engineers. It was reasonable to ask them to prevent an accumulation, but not an influx of gas He had filled up boxes with sand or wood blocks, so as to leave no space for accumulation.

Mr. Manville moved the amendment and urged the objections standing in the names of Portsmouth and Shoreditch.

Sir James Russell (Edinburgh) said it was most necessary to impress upon the gas companies that they ought to keep in their gas. At Edinburgh they had two explosions before they had a single dynamo or engine on the place. These were caused by a match, but the papers called them electrical explosions.

The **Chairman** said the Board had sent a circular to the gas companies on the matter

Mr. Crompton thought the true remedy was to insist on notice being given to the gas company as quickly as possible whenever gas was found, and then to put the responsibility on them. In the cases of the supply companies with which he had been concerned, the gas companies had accepted the responsibility and done their best to make good the faults Unless they could get the co-operation of the gas companies and their officials, it would be impossible to get immunity from explosions.

Mr. Morse in reference to the observations of the London Chamber of Commerce, said it seemed very hard to protect gas companies from the results of their actions by imposing regulations on the electrical companies.

Mr. Bayley said that his company had constantly met with gas leakages, and had rendered enormous service to the gas company in enabling them to trace the leakages

Mr. Gunyon, for the London County Council, supported the regulation with the addition of the words "so far as possible." Unless there was some outside pressure put on the companies, they would not get much done. Probably the best thing to do was to fill up the boxes. The gas companies were in possession of the ground, and the gas was in possession of the ground, and that must be considered by any new company coming in.

Prof Kennedy denied strongly that either municipalities or electric companies needed any outside pressure on this point. It had caused them very much trouble He would press seriously that the Board should accept the amendment of the Institution of Electrical Engineers It was a matter which had been very much discussed, and upon which they were practically unanimous.

The **Town Clerk of Hull**, speaking on behalf of the municipal corporations who possessed electric lighting installations, said that those corporations were just as much representatives of the public as the London County Council He must entirely disagree with the doctrine that had just been laid down that those who happened to be first in the field might conduct their operations under the streets in any way they chose without regard to the convenience of others or of those who might come after them.

Mr. Preece said that after 44 years' experience of the fight between electricity and gas pipes they had at last succeeded in getting at what they wanted. In London there were about 16 000 boxes in connection with the Post Office, and it was very rare for a year to pass without some explosions. They did not, however, get into the papers, and not much was heard about them. Where they had left the bottom of the box open, there had been trouble. They had been compelled to seal the bottom up, and in spite of all they could do they still had influx of gas. It was most difficult to prevent it, and he would therefore support the proposition made by Mr. Crompton on behalf of the Institution of Electrical Engineers. They could do no more than take all reasonable precautions. There was, however, a difference between keeping gas out of the small boxes of the Post Office and out of the large transformer boxes of the electric lighting industry.

The **Chairman** said what the Board would like to see was the gas companies obliged to keep their gas in and the electric companies obliged to keep it out. As it was impossible to make that absolute, he should be prepared to recommend the Board of Trade to accept the altered clause proposed by the Institution of Electrical Engineers or something equivalent. He would like it to be "to take reasonable precautions against influx," but he would not press that, and would adopt "accumulations," but with this exception—namely, that it must be made to apply to the conduits for electric lines, and that they must have some more protection when it came to street boxes The Board of Trade had only allowed transformers to be placed in street boxes subject to certain precautions The matter would affect the retention of the figures in Clause 45 when that came on to be discussed.

Prof Ayrton thought what had been said by the chairman would give satisfaction.

The meeting was then adjourned to the following day.

On resuming on Wednesday morning, before proceeding to Clause 28:

The **Chairman** said that he had carefully considered the very important representations which had been made to him on the

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previous day on the subject of the definition of what constituted a low pressure. The importance of that definition had been brought very clearly to his mind, but the points raised were highly technical and highly scientific, and he did not feel that he could give definite and final advice to the Board of Trade on what had been submitted with regard to the question. He thought, therefore, that it would be most convenient if the decision were reserved and the Board appointed a small expert committee—not exceeding three members—to consider the question and make a final suggestion to the Board of Trade.

(28) Where any electric line crosses or is in proximity to any metallic substance, special precautions shall be taken by the undertakers against the possibility of any electrical discharge to the metallic substance from their line or from any metal conduit, pipe, or casing enclosing their line.

Bournemouth Co.—Is the precaution to be in the nature of insulating from or connecting to the metallic substance? Connecting is likely to be far more permanent than insulating, but is more likely to cause telephone disturbance. Does not the continuous enclosing metallic pipe or casing, cross-connected at all boxes, etc, form a sufficient safeguard, especially if measures are taken to prevent metallic contact?

British Insulated Wire Co.—Suppose that the fact that a conductor has a metallic sheathing connected to earth will render unnecessary any special precautions under the circumstances mentioned.

Dublin Corporation.—Do not see necessity of this, as a continuously earthed iron conduit should be sufficient.

(29) All metal conduits, pipes, or casings containing any electric line shall be efficiently connected with earth; and shall be so jointed and connected across all street boxes and other openings as to make good electrical connection throughout their whole length.

Bolton Corporation.—That they have a large number of boxes and pipes which will require alteration to comply with the regulation. Submit that as all their high-pressure wires are concentric and armoured, with the armouring connected to earth, and the outer conductor also connected to earth, there is no necessity to connect across all the cast-iron pipes containing them.

British Insulated Wire Co.—Ask if regulation applies to cases in which concentric cables are used with the outer connected to earth and served over all with a leaden sheathing.

Cardiff Corporation.—That Clauses 29 and 30 appear to clash—*i.e.*, "All metal conduits . . . throughout their whole length" *v.* "Where isolated lengths, etc." Pressure clause refers only to a high-pressure system. This should be made clear.

Blackburn Corporation.—Second part—This has never been the practice on low-tension systems, and to enforce it, which is of no advantage, would cause great trouble and expense.

Institution of Electrical Engineers.—Line 2: after word "any" insert words "high pressure." Add at end of regulation, "except in the case of concentric cables where the outer conductor is efficiently connected to earth."

London Chamber of Commerce.—The word "casings" is ambiguous in this and other clauses. The second part of clause should not apply to concentric cables the outer conductor of which is earthed.

Westminster Co., Edinburgh Corporation, Aberdeen Corporation, Belfast Corporation Oldham Corporation, Sunderland Corporation.—Hope that clause, if retained, will be reworded. It is not clear at present. The phrase "good electrical connection" is employed in a very unusual sense.

Manchester Corporation.—Insert "high pressure" between "any" and "electric line." Or omit regulation entirely, it being unnecessary for so low a pressure as 400 volts.

Northern Society of Electrical Engineers.—Line 2: after "any" insert "high pressure." Add at end of clause, "except in the case of concentric cables where the outer conductor is efficiently connected to earth"

In reference to Clause 29 and the preceding clause and the observations on them, **Major Cardew** said that both clauses ought to stand. What should be done was that the electric lines should be enclosed in some protection of their own, or that there should be some kind of insulation between them and other people's pipes. He would, however, consider the points raised on the observations.

(30) Where isolated lengths of metal conduit, pipe, or casing are used for the protection of any electric line at road crossings or similar positions, there shall be interposed between such electric line and the conduit, pipe, or casing such additional insulating material as will prevent the possibility of any electrical charging thereof.

British Insulated Wire Co.—Ask if regulation applies to cases in which concentric cables are used with the outer connected to earth and served over all with a leaden sheathing.

Cardiff Corporation.—Clause appears to clash with Clause 29—*i.e.*, "All metal conduits . . . throughout their whole length," *v.* "Where isolated lengths, etc." Presume clause refers only to a high-pressure system. This should be made clear.

Manchester Corporation.—Alter to read "Where isolated lengths of conduit, pipes, or casing are used for the protection of any high-pressure electric line at road crossings or similar positions, the said conduit, pipes, or casing shall be efficiently connected to earth." Or, insert "high pressure" between "any" and "electric line."

Institution of Electrical Engineers.—Line 2: after word "any" insert words "high pressure." Line 5: omit word "additional." Line 6: for "the possibility of" read "as far as possible." At end of regulation add "but this regulation does not apply to concentric cables with the outer conductor connected to earth."

Westminster Co, Edinburgh Corporation, Aberdeen Corporation, Belfast Corporation, Oldham Corporation, and Sunderland Corporation—See remarks by same bodies on Regulation 29.

Northern Society of Electrical Engineers.—Alter to read as suggested by Manchester Corporation.

In reference to the proposal of the Manchester Corporation, the **Chairman** said it was affected by any modification they might make in the definition of high pressure.

Prof. Kennedy suggested the case of a cable laid in Doulton casing when an armoured cable went across the road.

Major Cardew thought that the wording of the clause should be "special precautions shall be taken," and it should be left to the undertakers to make them sufficient.

The **Chairman**: If it is altered to "special precautions shall be taken to prevent charging," that will be sufficient.

(31) Where the conductors of electric lines placed in any conduit are not continuously covered with insulating material, they shall be securely fixed in position, and no unfixed material of a conducting nature shall be contained in the conduit. Adequate precautions shall also be taken to ensure that no accumulation of water shall take place in any part of the conduit, and to prevent any access of moisture to the conductors or the insulators; and the latter shall be so disposed that they can be readily inspected.

National Electric Supply Co.—Experience shows that with the company's system of mains, inspection of insulators is practically unnecessary, no incrustation having been found.

London County Council—The condition as to ready inspection would apparently prohibit the use of such conduits as those used by the St. James and Pall Mall Company and the St. Pancras Vestry.

Notting Hill Co.—That the prevention of access of moisture to conductors or insulators is impossible, in view of the requirement that boxes should be ventilated.

Institution of Electrical Engineers.—Line 3: for "securely fixed" read "secured" Line 4: after word "unfixed," insert word "uninsulated." Line 8: after word "any" insert word "dangerous." Omit "and the latter shall be so disposed that they can be readily inspected"

London Chamber of Commerce.—The word "undue" should be inserted before the word "access" in line 8

Glasgow Corporation.—Line 3: words "shall be securely fixed in position" should be more definite. Copper strip in Glasgow is not wedged in the insulators, but is free to expand. Clause should be altered to allow this. Suggest words, after word "position," "copper strip in insulators held in position by the force of gravity shall be deemed securely fixed." Last two lines. It is impossible to inspect such culverts as are used in Glasgow. Suggest as an alternative, "that any length of culvert can be disconnected from the system for the purpose of testing."

Westminster Co., Edinburgh Corporation, Aberdeen Corporation, Belfast Corporation, Oldham Corporation, and Sunderland Corporation.—Understand that "securely fixed in position" means "not loose." Hope it may be reworded so as to make it clear that actual fixture in the sense of fastening is not intended.

Manchester Corporation.—Omit "and the latter shall be so disposed that they can be readily inspected."

Northern Society of Electrical Engineers.—Paragraph 2, line 3: after "any" insert "considerable" Paragraph 2, line 4: between "and" and "the" insert "as far as possible."

The **Chairman** accepted the suggestion to alter "securely fixed" to "secured."

Mr. Crompton said the last four words imposed an impossible condition on many existing systems

Major Cardew said it was desirable that the insulators should be inspected in case of deposits occurring

Prof. Kennedy said he had had the pleasure of a talk with Major Cardew on the subject, and he understood that what was meant was that a length should be able to be drawn out, or that by looking through the conduit with a light it could be seen if anything was wrong.

Major Cardew said that the Board of Trade must have some way of seeing whether there was a dangerous deposit.

Mr. Baynes said many of the mains at St. Pancras were too deep for this, and would have to be rearranged. They had something like £40,000 invested in these mains, and the rearrangements would be very costly. He had had the mains opened out for examination in many cases, and had been surprised to find them so clean. It was only at the straining bars that the troublesome deposits occurred.

In reply to **Mr. Wordingham**, the **Chairman** said that it would be sufficient to make the regulation prospective only, and in reference to a remark of **Mr Arnold**, of Gloucester, in reference to leaving the copper free to expand when it rested on the insulators, he remarked that the alteration made in the clause would cover that point.

(32) Any portions of any high-pressure electric lines placed above the service of the ground, or in any subway,

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shall be completely enclosed either in a highly glazed porcelain tube embedded in brickwork, masonry, or cement concrete; or in strong metal casing efficiently connected with earth, and so protected and guarded as to prevent accidental contact with the casing.

British Insulated Wire Co.—Ask if the regulation applies in cases in which concentric cables are used with the outer connected to earth and served all over with a leaden sheathing.

Halifax Corporation.—"Service of the ground" should be "surface of the ground."

House-to-House Co.—"Service" should read "surface"

Institution of Electrical Engineers.—Line 2: "service" should read "surface." Line 3: after "subway" insert "not in the sole occupation of the undertakers."

London Chamber of Commerce.—The words "or similar material" should be added after "tube" in line 4; the words "and so protected and guarded as to prevent accidental contact with casing" should be omitted.

Charing Cross and Strand Co.—Line 2: "service" should be "surface." In this clause and following "strong metal casing" doubtless covers or should cover lead covered armoured cables.

Northern Society of Electrical Engineers.—"Service" should read "surface." Omit "and so protected and guarded as to prevent accidental contact with the casing."

The misprint of "service" for "surface" having been corrected, the **Chairman** accepted the addition proposed by the Institution of Electrical Engineers.

After some further conversation on the proper wording of the clause, the **Chairman** suggested that "cement, etc.," might be left out, and after the word "and" "it shall be" inserted.

Major-General Webber wanted to know if insulated copper was to be still further insulated.

Major Cardew said there should be some further protection to the metallic casing to prevent people being brought into accidental contact with it. If high-pressure leads were brought up inside a post, the leads should be enclosed in a metallic casing, the casing being so arranged that it could not be touched.

Major-General Webber said if the casing was earthed there was no danger.

Mr. Gay suggested the case of a street lamp-pole. It was impossible to insulate that. Would a steel armouring on the cable be sufficient inside a lamp-post?

Major Cardew considered steel armouring would apply to that case.

Mr. Sayers asked that the regulation might at least be made retrospective. In the case of arc lamp connection the double metallic casing would be awkward.

Major Cardew said insulation was required only in order that the metallic casing should be protected so that it could not be touched.

Mr. Sayers: Would a wood casing apply?

Major Cardew: Yes. Where high-pressure lines were included in a casing connected with earth, it was desirable not to allow people to touch it.

Mr. Lewis (Wolverhampton) suggested that in lamp column work it would be impracticable to take cables protected with steel sheathing into the carriers.

Major Cardew said he had been convinced, and would suggest the omission of the last words from "and" to "casing."

Prof Kennedy said the regulation would compel them to enclose lines going up a lamp-post with a "glazed porcelain tube" or a "strong metallic casing."

Major Cardew said that with the alteration proposed the lamp-post was the casing.

Major-General Webber said the circumstances of lamp-posts and subways were different, and there should be two rules.

Mr. Morse suggested the insertion of "or of some similar material" after the word "tube," rather than the specifying of one particular class of goods.

Major Cardew said he quite appreciated the object of the London Chamber of Commerce in making the suggestion. Would not "highly insulating tube" do?

Mr. Morse preferred "highly-insulating material."

The **Chairman** agreed to this, and in answer to **Mr. Baynes**, said the clause would be retrospective. The amended clause therefore reads: "Any portions of any high-pressure electric lines placed above the surface of the ground, or in any subway, shall be completely enclosed either in a highly insulating material, embedded in brickwork, masonry, or concrete, or in strong metal casing efficiently connected with earth."

(33) Every high-pressure electric line transmitting more than 50,000 watts, or used for the supply of energy to transformers placed in street boxes, shall, except within the generating station, be entirely enclosed in strong metal casing efficiently connected with earth, and such casing shall not contain any low-pressure electric line.

Bournemouth Co.—Regulation will be difficult to carry out, and yet leave the lines accessible for jointing, testing, and repairing, in street boxes, unless a continuous lead-foil coating earthed be taken as a compliance.

Institution of Electrical Engineers.—For Regulations 33 and 34 substitute the following: "Every high-pressure electric line transmitting more than 50,000 watts shall, except within the generating station or sub-station, be entirely enclosed in strong metal casing efficiently connected with earth, or in stoneware or other suitable casing, and such casing shall not contain any low-pressure electric line unless this line is a concentric cable with the outer conductor earthed."

Northern Society of Electrical Engineers.—Add at the end of regulation "unless the main be concentric with the outer conductor earthed."

Chelsea Co.—The provisions of this clause, where Callender-Webber conduits are used, would be inconvenient and costly of application. Experience of the company proves them to be unnecessary.

Portsmouth Corporation and Shoreditch Vestry.—Regulation would materially affect the works of the Portsmouth Corporation. The Corporation are using a highly glazed clay conduit for carrying insulated conductors. The high-tension mains will have in many cases to transmit more than 50,000 watts. The outer conductor is earthed, and therefore any portion of the concentric is only removed from earth by the metallic resistance of the outer conductor, and it is doubtful whether any metallic casing would have a lower resistance to "earth" than is provided in the conductor itself.

(34) High-pressure electric lines not intended to transmit more than 50,000 watts may be enclosed either as provided in the preceding regulation, or in glazed stoneware casings properly laid and jointed in cement at a depth of not less than 2ft. below the surface of the ground and sufficiently protected against breakage.

Institution of Electrical Engineers.—See observation on Regulation 33.

Northern Society of Electrical Engineers.—Omit regulation entirely.

Chelsea Co.—Unnecessary. If glazed stoneware is permissible, then Callender-Webber casing should be equally so.

Westminster Co, Edinburgh Corporation, Aberdeen Corporation, Belfast Corporation, Oldham Corporation, and Sunderland Corporation.—The effect of this clause would be entirely to prevent the laying of any high-tension lines under footways, for it very seldom happens that there is anything like a depth of 2ft. between the footway and the top of the cellars below.

Mr. Crompton said the amended clause proposed by the Institution of Electrical Engineers had been the result of a long debate by a large committee. He thought it would prove simpler and more workable.

Mr. Hammond was thoroughly in accord with the amended clause. Owing to the feelings of the Board of Trade on the subject, he had been compelled to use iron culverts in high-tension work where he would have himself preferred stoneware. He thought Clauses 33 and 34 should be taken together—[The **Chairman**: We will do that]—and he hoped they would be permitted to use stoneware culverts whatever the load might be. He would also call attention to the stipulation in Clause 34, that where stoneware culverts were used they should be placed at a depth of not less than 2ft. below the surface. That regulation would take away all the advantage of the permission to use stoneware culverts. Stoneware was only possible when the conductors were placed below the pavements, where a depth of 2ft. was never practically possible, since in the course of a length of street they were sure to come on cellars under the pavement. If stoneware culverts were to be permitted, it must be under a less stringent regulation than one that prescribed a depth of 2ft.

Mr. Sayers thought brick boxes should be accepted. It was well known that brick boxes were used, and under the regulation it would be necessary to take the cables through them cased in a "strong metallic casing." That would prevent getting at the cable for inspection, and would make the operation of jointing difficult and tedious. He called attention to the suggestion of a lead-foil coating.

The **Chairman** thought they might go back to No. 8 of the old regulations and cut out 33 and 34 altogether.—The old clause reads as follows: "Where any high-pressure conductor is laid within a less distance than 18in. from any low-pressure conductor, or from the surface of the ground, or where any low-pressure conductor is laid within the above-mentioned distance from any previously laid high-pressure conductor, efficient means shall be taken to render it impossible that the low-pressure conductor or the surface of the ground shall become electrically charged by any leakage from or defect in the high-pressure conductor."

Mr. Crompton said this old regulation would be very generally preferred.

IV.—*Street Boxes.*

(35) All street boxes which contain any vacant space shall be so constructed as to prevent any influx of gas or water either from the adjacent soil or by means of any pipes, and ample provision shall be made by ventilation or otherwise for the immediate escape of any gas which may by accident have obtained access to the box, and for the prevention of danger from sparking.

Veale and Co.—That it will be difficult to prevent the influx of gas or water from the adjacent soil, etc.

Bournemouth Co.—That no practicable means are known which will absolutely and under all circumstances prevent the influx of gas or water. Danger from sparking is practically nil with concentric cables, especially if the outer conductor is earthed and the cable lead-foiled or armoured.

Dublin Corporation.—It is practically impossible to carry out this regulation as regards prevention of influx of gas or water.

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It can be got rid of as at present. See observations of Corporation on Regulation 27.

Sheffield Co.—The efficient ventilation of boxes appears to be a difficulty.

London County Council.—If this regulation could be enforced there would be little danger from street boxes, but at present such a result appears to be hopeless.

Cardiff Corporation.—Corporation's boxes are open at the bottom, to facilitate drainage of water. Corporation have at present no regular system of ventilating their pipes other than by the transformer-boxes, which are ventilated by means of pipes carried up against adjoining buildings, and on the arc light circuits by means of the street lamp posts.

Yorkshire House-to-House Co.—Suggest that use of means for keeping mains free from gas and water should be held to be sufficient, without requiring prevention of influx by a special construction of the conduits and boxes.

Islington Vestry.—Object to the requirement as to preventing influx of gas or water. It will seriously increase the responsibility of undertakers

Institution of Electrical Engineers —Omit entirely. See observation on Regulation 27.

London Chamber of Commerce —Omit entirely, or should be made to accord with 27 as altered.

Chelsea Co —Ventilation of street boxes is a very difficult matter, and would appear rather to draw in a supply of gas from surrounding soil Frequent inspection gives greatest security.

Glasgow Corporation.—Impossible to prevent access of gas. Suggest words "that all reasonable precautions shall be taken."

Portsmouth Corporation and Shoreditch Vestry.—Object for same reason as in case of Regulation 27. Provision for preventing accumulation of gas only should be adhered to.

Westminster Co, Edinburgh Corporation, Aberdeen Corporation, Belfast Corporation, Oldham Corporation, and Sunderland Corporation.—See remarks of same bodies on Regulation 27.

Manchester Corporation and Northern Society of Electrical Engineers.—Between "to" and "prevent" insert "as far as possible."

In reference to this clause, which had to a certain extent been condemned by anticipation, and what had passed before during the discussion on Clause 27, the **Chairman** said that there must be some additional precautions with regard to street boxes for transformers beyond what was considered sufficient in the altered form of Clause 27. He suggested for discussion: "In the construction of street boxes containing any vacant spaces, reasonable means shall be adopted so far as possible to prevent any influx of gas or water, and reasonable means by means by ventilation shall be adopted to allow of the escape of gas and prevent danger from sparking."

The **Representative** of the Liverpool Electric Supply Company said that would apply to all street boxes, and not to transformer-boxes only.

Major Cardew: That is so.

The **Chairman**: Is it desirable to ventilate all street boxes?

Several Representatives: No, no.

Major-General Webber said that some of the London local authorities had arrived at the conclusion that there were serious reasons against ventilating every box.

Mr. Hammond did not object to the altered clause if it was limited to transformer-boxes.

It was pointed out at this stage that the word street boxes covered very different things—for instance, junction-boxes, house boxes, and transformer-boxes.

Mr. Gay said it would be impossible to make the boxes air-tight without glands. The actual air-space in the ordinary street box was very small, and would not be a serious matter if proper ventilation was provided. The explosion of a box with a loose cover was less serious than one supposed to be perfectly gas-tight and air-tight.

Mr. Shoolbred thought the word "ventilation" was intended to apply to the pit in which the box was placed The practice he had pursued was to fill up the box, and if that was done the box need not be ventilated.

The **Chairman** said that special precautions were necessary for street boxes used for transformers, and suggested as a definition "boxes containing any apparatus."

Mr. Hammond would make it absolutely compulsory in transformer-boxes to prevent the influx of gas or water, and therefore the provision of ventilation must be omitted. The clause should end at the word "pipes."

The **Chairman** said he was convinced by the discussion of the subject at the Board of Trade that if gas or air got in, it should have an opportunity of getting out again. If there was no means of it getting out, there might be a very dangerous explosion.

Mr. Hammond suggested that the matter should be left in the hands of the Board of Trade. All the boxes they were discussing had been approved by Major Cardew.

Mr. Scott mentioned some cases where brick chambers had been cracked by subsidence of the ground. At Hanley the gas-mains were cracked by subsidence owing to the colliery workings underneath, and the pipes for electric cables were found to be full of gas before the cables were put in. Ventilators were fixed and there had been no trouble

Mr. Gunyon thought there should be a special clause for transformer-boxes and large street boxes, since the latter varied from an 8in. cube to 8ft. or 10ft., or more. If the clause were applied to transformers and to boxes of one cubic yard in capacity, there might be a different regulation for other boxes.

Prof. Ayrton thought they should first of all settle the question of transformer-chambers, and whether they should be well ventilated or perfectly gas-tight.

Mr. Gunyon said the size of the box was important, as well as what it contained.

Mr. Crompton said he was ready to agree with Mr. Gunyon's amendment.

Major-General Webber said that the explosion of a large or small box would be about equally dangerous to anyone standing just over it.

Mr. Hammond thought a cubic yard would prove too small a limit for a box containing cables. The dangerous thing was the box containing the transformer. It was a much easier thing to prevent influx of gas into transformer-chambers than into ordinary boxes. It would be most burdensome to apply it to all street boxes.

Major-General Webber said the limit was inconsistent, for they had a much larger space in a large conduit than one cubic yard

Major Cardew pointed out that it was not concentrated at one point in that case.

Prof. Kennedy remarked that on the continuous current system many boxes were made large, so that a man could get into them for the purpose of getting at the cables to move or alter them or get them out. If the box was in communication with the conduit, it was impossible to prevent the influx of gas.

Mr. Spence (Hammersmith) proposed to insert after the word gas, "and street boxes with more than one cubic yard of space shall be properly ventilated." It would be throwing too great a responsibility on the undertakers to compel them to keep gas out of ordinary boxes.

A **Representative** of the Liverpool company asked that the limit should be increased to two cubic yards to meet their case. They had a very large number of boxes, and had been nine or ten years without any trouble occurring.

Mr. Morse asked, from the legal point of view, that care should be taken in the wording of the clause that in reference to the limitation in the space the box should not be taken to include the conduits

The **Chairman** said Clause 35 should apply only to street boxes containing transformers, and should read "In the construction of street boxes containing transformers efficient means should be taken to prevent any influx of gas or water from the adjacent soil, etc." He would consider further whether it was possible to accept Mr. Gunyon's suggestion as to a space limit for other boxes.

Mr. Geipel: It is sometimes the custom to put very small transformers into boxes.

The **Chairman**: I cannot accept that for a moment.

Mr. Patchell, Charing Cross and Strand Electricity Supply Corporation, strongly supported the suggestion from Liverpool, that the limit should be two cubic yards. His company had several boxes of 1½ to 2 cubic yards which had been worked for the last five years, and which they could not ventilate without allowing water to enter.

The **Chairman** said he would consider if the Board would carry out Mr. Gunyon's suggestion.

Some conversation followed as to what was held to constitute the "box." **Mr. Crompton** remarking that they had first the transformer, then the air-tight case which was called the transformer box, then the street box in which this was put, also called the transformer-box. Another word for this was wanted.

The **Chairman** said the word "chamber" was used. He had always insisted that the cavity was the chamber.

Mr. Crompton said what was suggested was that the iron casing around the transformer itself must be made air-tight.

Eventually the regulation was settled as follows: "In the construction of street boxes used as transformer-chambers reasonable means shall be adopted to prevent any influx of gas or water either from the adjacent soil or by means of any pipes, and ample provision shall be made by ventilation or otherwise for the immediate escape of any gas which may by accident have obtained access to the box, and for the prevention of danger from sparking."

(36) The covers of street boxes shall be properly secured, and shall, where the box contains high-pressure apparatus, be connected to strips of metal laid immediately underneath the adjacent roadway or pavement.

Bolton Corporation.—Submit that, under their present conditions of working, the connection to strips of metal, etc., is unnecessary.

British Insulated Wire Co.—Ask if regulation applies in cases where concentric cables are used, with the outer connected to earth and served over all with a leaden sheathing.

Dublin Corporation.—This does not appear necessary when iron conduits are used, and should be put in more definite terms, giving conditions as to when it is required.

Islington Vestry.—If cables are included in the word "apparatus," they object to the regulation.

Institution of Electrical Engineers.—Line 1: omit "properly secured" and insert "so constructed that they can only be opened by proper appliances." Line 2: after "apparatus" insert "other than cables"

London Chamber of Commerce —The words "other than cables" should be added after "apparatus" in line 2.

Chelsea Co.—Presume this clause is limited to apparatus other than mains

Charing Cross and Strand Co.—"Properly secured" should mean that some special appliance is necessary to open the box, not necessarily a lock and key.

Westminster Co., Edinburgh Corporation, Aberdeen Corpora-

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tion, Belfast Corporation, Oldham Corporation, and Sunderland Corporation.—Understand that "strips of metal" may be a sufficiently broad flange to the frame of the box. Probably the wording can be altered to make the matter clear.

Northern Society of Electrical Engineers.—Alter to read: "The covers of street boxes shall be properly secured, and the cover frames shall, when the boxes contain high-pressure apparatus, be efficiently connected to earth."

Eastbourne Co —Presume that connection to strips of metal, etc., would not be necessary where the box and lid are of iron and in metallic connection with the system of iron conduits

Mr. Crompton moved the amendments of the Institution of Electrical Engineers, and the second of these was accepted so far as concerns concentric cables with the outer earthed.

Mr. Hammond asked if, when the box was iron and the lid had a wide iron flange, these metal strips were a necessity. He considered such an octopus arrangement simply an unnecessary expense.

Mr. Nesbitt pointed out that if the cover were sufficiently connected to earth the arrangement would be perfectly safe.

The **Chairman** said he would consider how to meet the points raised.

(37) The casing of any high-pressure electric lines shall be continued within street boxes.

Bournemouth Co.—Regulation will be difficult to carry out, and yet leave the lines accessible for jointing, testing, and repairing, in street boxes, unless a continuous lead-foil coating earthed be taken as a compliance.

British Insulated Wire Co.—Ask if regulation applies to cases where concentric cables are used with outer connected to earth and served over all with a leaden sheathing.

Dublin Corporation.—Do not see how this is to be carried out if the cables are to be accessible at the boxes. Where the boxes are iron and connected to the pipes it cannot be necessary. In the case of brick or concrete boxes a metal shield along the sides should be sufficient, but free access to the cables must be preserved.

Institution of Electrical Engineers.—This regulation appears to be covered by No. 29.

Chelsea Co.—With Callender-Webber casing, which has been proved to be absolutely successful and free from defect, it would be impossible to carry out the provisions of this regulation.

Charing Cross and Strand Co.—Remarks in Clause 27 apply here.

Dover Co. and County of London Co.—If "street boxes" include "transformer-boxes," words "except transformer-boxes" should be added, as it is impossible to continue the casing of high-pressure lines within transformer-boxes unless lead or other lapping of the cables be held to be of sufficient compliance.

Westminster Co, Edinburgh Corporation, Aberdeen Corporation, Belfast Corporation, Oldham Corporation, and Sunderland Corporation.—"This certainly does not explain itself."

Northern Society of Electrical Engineers.—A definition is required for the word "casing."

Major-General Webber said the regulation would make it difficult to draw cables in and out. There were two kinds of casing in use—metallic and non metallic—and they should not be dealt with in the same way. The rule ignored non-conducting casing, and should be revised to meet the actual circumstances. Many ways would suggest themselves to Major Cardew of obviating the results which had led to the rule.

Major Cardew said one of the most dangerous parts of a high-pressure system was where cables crossed in street boxes. If a non conducting casing was used it should be carried across the box. The cables should not be taken across the box in air with probably an extra length coiled up in the box. This had been the cause of a serious breakdown.

Major-General Webber said the old rule entirely covered the case. He would suggest that it should be left to the undertakers to provide that the high-pressure cables should be so protected and separated from the low-pressure cables that the danger arising out of leakage should be obviated.

In reply to **Mr. Gay**, the **Chairman** said the word "casing" included steel armour.

Mr. Sayers wanted to know what would be the use of a street box if they were to be obliged to continue the casing of the cable through it? It was most important to take off the supply for a minimum amount of time when it was necessary to make a joint. The lead-foil casing which he proposed could be easily and quickly taken off and put on again.

Major Cardew said one of the dangers to be guarded against was that arising from minute sparks passing from one cable to another when these were in air.

Ultimately, the **Chairman** said the regulation would be struck out, that the old regulation (No. 15) might be adopted. This old clause reads as follows: "Where any street box contains high-pressure conductors, efficient means shall be taken to render it impossible that the covers or other exposed parts of these boxes or any adjacent material forming the surface of the street, shall become electrically charged, whether by reason of leakage, defect, or otherwise; and all street boxes shall be efficiently protected against any accumulation of gas or water, and their covers so secured that they cannot be opened except by means of a special appliance."

V.—*Converting Stations.*

(38) All converting stations, or points in a system of distribution to which a high-pressure supply is given from generating stations, and from which a low-pressure supply is given to consumers, shall be established in suitable places which are in the sole occupation and charge of the undertakers.

London County Council.—Suggest, for Board's consideration, whether some limit of the power to be concentrated in any one station might not be inserted, and also a provision ensuring the presence of an attendant either at all times in important cases, or at stated intervals in less important cases.

Dover Co. and County of London Co.—"Suitable" is likely to lead to repeated references to the Board of Trade. Suggest: "Converting stations shall be established in places which are within the sole occupation and charge of the undertakers, and shall be suitably constructed so as to prevent as far as possible any influx of gas or water from the adjacent soil."

London Chamber of Commerce.—The words "established in suitable places which are" should be omitted.

Chelsea Co.—Presume that a properly constructed chamber, etc., may form part of any other building.

Institution of Electrical Engineers.—Lines 4 and 5: omit "established in suitable places which are"

The word "converting" in the first line having been altered "transforming,"

Mr. Gunyon opposed the amendment of the Institution of Electrical Engineers to omit "suitable places, etc."

Some conversation followed as to the case where the transformers were placed on the consumer's premises and how the undertakers were to be in occupation of a portion of the consumer's premises.

Prof. Ayrton thought it would be impossible for the consumer to hand over a portion of his property to the supplying company. He would not be willing to do that, and, besides, there might be legal difficulties

Mr. Callender asked if a transformer-chamber built above the street would be considered in the occupation of the undertakers; and **Mr. Hammond** wanted to know if the regulation would oblige the companies to rent a corner of a consumer's cellar if a transformer had been placed there.

The **Chairman** said the regulation applied only to transformer stations, and therefore it would not be necessary to do so unless the particular transformer supplied more than one consumer.

Prof. Ayrton remarked that the question then arose as to who was to insure the property.

After some further conversation, the **Chairman** said the best thing to do would be to go back to the old regulation, which had worked very well. This reads: "Transforming stations, or points in a system of distribution to which a high-pressure supply is given from generating stations, and from which a low-pressure supply is given to one or more consumers, and which are not on the consumer's premises, shall be established in suitable places which are in the sole occupation and charge of the undertakers."

VI.—*Consumer's Premises.*

(39) The undertakers shall be responsible for all electric lines, fittings, and apparatus belonging to them, or under their control, which may be upon the consumer's premises, being maintained in a safe condition and in all respects fit for supplying energy.

Burnley Corporation.—That "or" in line 2 should be "and." Submit that it should be made clear that the undertakers' responsibility extends only to mains and apparatus belonging to them and under their exclusive control—*i.e.*, service lines and meters—and not to the consumer's own fittings.

(40) In delivering the energy to the consumer's terminals the undertakers shall exercise all due precautions so as to avoid risk of causing fire on the premises.

(41) A suitable safety fuse or other automatic disconnector shall be inserted in each service line as close as possible to the point of entry to any consumer's premises, and contained within a suitable locked receptacle of fire-proof construction.

Liverpool Co.—It has not been their practice to mount the safety fuses in a locked receptacle. The fuses are for the safety of the consumer, and it would be inconvenient if access to the fuses were prevented, it being assumed that the key of the receptacle would be held by the undertakers. All the company's service lines are now protected by fuses in street boxes, and company ask that the regulation, if insisted on, may not be retrospective.

Burnley Corporation.—Omit "locked" and insert "securely fastened and sealed."

Huddersfield Corporation.—Suggest that if the case were screwed up and sealed, it would be more advantageous and less inconvenient than a lock and key

British Insulated Wire Co.—Would not a screw cover with the seal of the undertakers on it meet the requirements instead of a lock?

Birmingham Co.—Suggest addition of word "double-pole" between "suitable" and "safety fuse."

London County Council.—A special regulation appears to be required to secure as far as possible that all main fuses installed shall be placed in cases which either by construction or other protection shall be thoroughly watertight. Two fires have recently occurred in London in consequence of water obtaining access from the street to the main fuses in the house.

Walsall Corporation.—Words "or sealed" should be inserted after "locked."

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Cardiff Corporation.—Their terminal boxes are "sealed," not "locked."

Notting Hill Co.—"Locked" should be "sealed."

Southport Corporation.—For "locked" read "sealed or locked."

Lancaster Corporation.—For "a suitable locked receptacle" read "a suitable receptacle securely fastened and." This would enable the cut-outs to be fastened by screws and sealed with a lead seal, as is usually done.

Blackburn Corporation.—Practice is to "seal," which is more secure than lock and key."

Wolverhampton Corporation.—"Suitable locked receptacle" should read "suitable locked or sealed receptacle."

Institution of Electrical Engineers, London Chamber of Commerce, and Northern Society of Electrical Engineers.—Line 4: after "locked" insert "or sealed."

Manchester Corporation.—Line 4: "locked." Corporation prefer sealing. Good locks are so expensive as to be prohibitive. Also, seals would leave evidence of a box having been tampered with, which a lock would not.

Glasgow Corporation.—Line 4: after "locked" insert "or sealed."

Charing Cross and Strand Co.—Line 4: insert "or sealed"; "sealing" is generally preferable.

Phœnix Fire Office.—We consider undertakers should place up a switch and a cut out on each service line at the point of entry into the premises, so that the current can be entirely switched off At present the main switches in the majority of cases have to be placed up by the consumer, who often finds it impossible to have them fixed in the proper place on account of the manner in which the service lines have been brought in

Eastbourne Co.—The fuses being themselves constructed with an incombustible case and cover, it would be unnecessary to fix them in a locked receptacle of fireproof construction. Company fix them in a locked wooden box with the meter.

On Clause 41, it was suggested from Manchester that a seal was preferable to a lock, since it was known for a certainty if a seal had been tampered with The Liverpool company also desired that the words should be "locked or sealed."

Prof Kennedy asked if the rule meant that the fuse-boxes must be cast iron? If so, it ought not to be retrospective. There were 1,800 wooden fuse-boxes in the consumers' premises in that district (Westminster). They might, however, be lined with asbestos. If the rule did not apply to fuses on the consumers' premises, did it mean there was to be another fuse in the street?

Mr. Heaphy wanted the words to be "at the point of entry," instead of "as close as possible to the point of entry." The consumer ought to be able to turn the current entirely off his house Cut-outs were often found placed more than 4ft. from the point of entry, and the switch 10ft. or 12ft. off, with the meter between the switch and the cut-out.

Mr. Cottam pointed out that the point of entry was often damp and most unsuitable for switches, etc.; also that consumers preferred their main switches in accessible places.

The **Chairman** thought it might stand as close as possible to the point of entry, and on **Mr. Hammond** rising to support Prof Kennedy's plea that the clause should not be retrospective, the **Chairman** remarked that the Board would allow a reasonable time for alterations, but that a fireproof construction was highly necessary.

Mr. Wordingham said at Manchester they had carried wrought-iron service pipes right up to the fuses — the consumer often wanted the main switch to be placed in the shop; and **Mr. Erskine** remarked that the consumer naturally wanted the switch in the house, where he could get at it, and not, say, in a cellar across a yard.

The amendment allowing sealing was accepted.

(42) All low-pressure electric lines and apparatus placed on any consumer's premises shall be highly insulated and thoroughly protected against injury to the insulation or access of moisture, and no metal forming part of the electric circuit shall be exposed so that it can be touched. All electric lines shall be so fixed and protected as to prevent the possibility of electrical discharge to any adjacent metallic substance.

Dublin Corporation.—This appears to apply to "wiring" on consumer's premises, which is done by the consumer. It should be placed beyond question whether the regulation applies to all such low-tension work—including switches—as in most cases it is not carried out by the wiring contractors.

Northern Society of Electrical Engineers.—Line 2: after "premises" insert "by the undertakers." Line 6: after the word "lines" insert "under the control of the undertakers."

London Chamber of Commerce.—Same as Northern Society, and the word "undue" should be inserted before the word "access" in line 4.

Manchester Corporation.—After "premises" insert "by the undertakers." After "lines," in line 6, insert "under the control of the undertakers."

The amendment from Dublin was withdrawn and the clause passed.

(43) Where transformers are installed within buildings on consumers' premises, they shall be contained in a fireproof chamber, securely locked, and the high-pressure service lines in highly glazed porcelain tubes bedded in chases cut in brickwork or masonry.

Bournemouth Co.—The requirements of the clause may often be impracticable in execution, especially in small installations. The service cables installed in the manner proposed would be inaccessible for examination or repair. The alternative of "strong metal casing efficiently connected to earth," amply guarantees safety. The regulation would impose unnecessary expenditure and interference with consumers' premises. Agree to fireproof chambers in cases of large consumers; but claim that metallic pipes give greater security than porcelain tubes, on account of the earthed metal shield.

Bolton Corporation.—That previous regulations allowed transformers to be placed in a strong metal casing connected to earth. If they have to provide a fireproof chamber for each transformer, it may be better to place them under the footpaths in an iron box rather than inside the premises.

Huddersfield Corporation.—Where transformers are installed on consumers' premises, would it not be equally safe to run the high-pressure service lines in a metal pipe connected to earth? Submit that earthenware pipes are not so strong as metal, and are much more costly to fix.

Dublin Corporation.—Too stringent. All high-pressure cables are contained in iron pipes until inside the transformer-chamber, and this is sufficient protection, as access to the chamber is only had by qualified members of the staff.

Halifax Corporation—Old Regulation 18, which allows the high-pressure service line to be placed in metal casing, appears to be preferable. Wrought-iron pipe for high pressure is preferable to glazed porcelain, as it affords a better mechanical protection, it can be used in longer lengths, and the jointing of lengths is more easily carried out. In many cases the wrought-iron pipe can be arranged to screw into the transformer case so as to ensure a complete metallic covering for the high-pressure cable, and also efficient earthing of the transformer case.

Sheffield Co—Assume that the provision of transformers, which are completely enclosed in metal cases with an iron screen between the primary and secondary windings connected to earth, meets the requirements of this regulation.

Dover Electricity Co and County of London Co.—Suggest addition of "or in iron pipes efficiently connected to earth" after "masonry." This has been carried out in many places.

Yorkshire House-to-House Co.—Object to clause, which would cause serious inconvenience and expense. Present regulation meets all reasonable requirements. Use of porcelain tubes for high pressure service lines would involve difficulty in coupling to the street mains, and such tubes would also be difficult to connect to the iron transformer-cases Present practice works satisfactorily—*i e*, to fix transformer in a fireproof cast-iron case, and to carry the cable from the street main to the transformer-case in wrought-iron tubes, which, like the case, are connected to earth.

London Chamber of Commerce.—The words "or sealed" should be inserted after word "locked" in line 3. The words "or other equally effective material" should be inserted after the word "tubes" in line 4.

Northern Society of Electrical Engineers.—Alter to read: "Where transformers are installed within buildings on consumers' premises they shall either be contained in a fireproof chamber, securely locked, or within a metallic receptacle efficiently connected to earth, such receptacle to require the use of a special tool before it can be opened, and in either case every portion of the framework of the transformer shall be efficiently connected to earth. The high-pressure service lines shall be contained either in highly-glazed porcelain tubes bedded in chases cut in brickwork or masonry or in metallic tubes efficiently connected to earth."

Eastbourne Co.—Regulation should be modified to permit the use of metal casing well earthed as in Regulation 32.

Institution of Electrical Engineers.—Line 3: for "chamber" read "case," for "locked" read "fastened." Omit words "highly . . . masonry" and insert "protective tubes or in metal casings connected to earth."

Mr. Shoolbred asked at whose expense were the alterations necessary to comply with this clause to be made, and the **Chairman** said it depended on the particular provisional order.

Mr. Shoolbred thought all companies should be upon the same footing, and the **Chairman** remarked that the question arose when the system was approved by the Board.

Mr. Sayers proposed that Clause 18 of the old regulations should be substituted for the present clause. That had answered perfectly well in the case of small installations of from one to four kilowatts The provision was one which they could not get consumers to agree to. The masonry cover was almost prohibitory. On the other hand, it might be necessary in cases of 10 to 20 kilowatt installations.

Mr. Rider agreed with Mr. Sayers that the cost would be prohibitory.

Mr. Heaphy wanted the clause to stand, but the **Chairman** said the consensus of opinion was in favour of going back to the old regulation as proposed by Mr. Sayers. The clause will therefore read: "Where the general supply of energy is a high-pressure supply, and transforming apparatus is installed on the consumers' premises, connected to the distributing mains by high-pressure service lines, and to the consumers' terminals by low-pressure service lines, the whole of the high-pressure service lines, conductors, and apparatus, including the transforming apparatus itself so far as they shall be on the consumers' premises, shall be completely enclosed in solid walls, or in strong metal casing efficiently connected to earth, and securely fastened throughout."

(44) If the undertakers are reasonably satisfied, after making all proper examination by testing or otherwise,

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that a connection with the earth exists at some part of a circuit of such resistance as to be a source of danger, and that such connection does not exist at any part of the circuit belonging to the undertakers, then and in such case any officer of the undertakers, duly authorised by them in writing, or, if the undertakers so require, an electric inspector may, for the purpose of discovering whether such connection with the earth exists at any part of a circuit within or upon any consumer's premises, at all reasonable times, after giving one hour's notice of his intention to do so, enter any such premises and disconnect the consumer's wires from the service lines, and may require the consumer to permit him to inspect and test the wires and fittings belonging to the consumer and forming part of the circuit. In any case where the undertakers require the services of an electric inspector under this regulation they shall pay him the prescribed fee.

Institution of Electrical Engineers, Northern Society of Electrical Engineers, and London Chamber of Commerce.—Add at end of regulation, "and in case the fault be found to exist on the consumer's premises, the undertakers shall be entitled to recover the said fee from the consumer."

Westminster Co., Edinburgh Corporation, Aberdeen Corporation, Belfast Corporation, Oldham Corporation, and Sunderland Corporation.—Hope something may be done to give undertakers more power to repair in the case of defects which they may think may lead to serious accidents.

(45) If on such testing the officer or the electric inspector discovers that a connection exists between the consumer's wires and the earth, and that such connection has an electrical resistance not exceeding 5,000 ohms, or if the consumer does not give all due facilities for such inspection and testing, the undertakers shall forthwith discontinue the supply of energy to the premises in question, giving immediate notice of such discontinuance to the consumer, and shall not recommence such supply until they are reasonably satisfied that such connection with the earth has been removed. Provided that in cases where the maximum power taken by any consumer exceeds 25,000 watts, the consumer's wires may be divided for the purposes of this testing into separate circuits, the insulation resistance of each of which shall exceed 5,000 ohms.

Bournemouth Co.—Limit of 5,000 ohms is too low, and may be inconsistent with Clause 10. Minimum should be proportionate to size of installation and the current used, as is usual in supply companies' regulations as to tests before connecting, and in fire insurance companies' regulations.

British Insulated Wire Co.—Last paragraph. Think the separate circuits into which large consumers' wires may be divided should be specified.

Sheffield Co.—Consider 5,000 ohms resistance much too low, and calculated to encourage wiring contractors in practices which are detrimental to the interests of supply companies.

London County Council.—5,000 ohms seems to be a very low figure. The minimum resistance might be raised without the slightest hardship in any case to at least 50,000 ohms; or it would probably be better to specify the resistance varying with the number of lamps or other current-consuming devices installed. If this be done, it might be possible to reduce the variation of pressure allowed by Regulation B (7) from 4 per cent to 3 per cent.

Notting Hill Co.—Consider that the insulation resistance of any installation should be on a sliding scale, according to the number of lights, and not to one fixed standard.

Dover Co. and County of London Co.—Installation specified is too low. Suggest minimum of 50 megohms divided by number of 8-c.p. lamps in circuit. The second paragraph does not limit the number of separate circuits.

St. James and Pall Mall Co.—In the latter part of the clause, it is not stated into how many separate circuits a consumer of above 25,000 watts may divide his wires.

Manchester Corporation.—Line 4: 5,000 ohms far lower than should be allowed. Corporation consider 10,000 ohms, the limit fixed by their present regulations, is too low. Board of Trade allowed a minimum of 10,000 ohms in Manchester.

Manchester Corporation.—Alter 5,000 ohms to 100,000. If work is done even moderately well the insulation resistance should exceed 10,000 ohms. Lowering the standard would encourage contractors to carry out bad work, and the Corporation find it difficult even now to enforce their by-laws for wiring on consumers' premises.

Northern Society of Electrical Engineers.—Alter minimum of 5,000 ohms to 20,000.

Institution of Electrical Engineers.—Omit proviso.

(46) If any consumer is dissatisfied with the action of the undertakers either in discontinuing or in not recommencing the supply of energy to his premises, the wires and fittings of such consumer may, on his application and on payment of the prescribed fee, be tested for the existence of connection with the earth by an electric inspector. This regulation shall be endorsed on every notice given under the provisions of the last preceding regulation.

Institution of Electrical Engineers and London Chamber of Commerce.—Substitute the following regulation: 46. (*a*) If any consumer desires the undertakers to commence the supply, or if he is dissatisfied with their action under the preceding clause, the wires and fittings of such consumer may, on his application, and on payment of the prescribed fee, be tested by an electric inspector, and if the insulation resistance of the consumer's installation is equal to 75 megohms divided by the number of points for taking off current, the undertakers shall make the connection and refund the consumer the fee paid to the electric inspector; (*b*) if the undertakers have reason to believe that an installation already connected to their mains is in a faulty condition, they may test such installation, and if the insulation resistance is found to be less than 75 megohms divided by the number of points for taking off current, the undertakers may discontinue the supply; and in case of difference an electric inspector is to be called in by either party and his fee is to be paid by the party at fault. This regulation shall be endorsed on every notice given under the provisions of the last preceding regulation. Consider it desirable that the position of undertakers in consumers' premises should be clearly defined, as suggested in the regulation submitted.

Northern Society of Electrical Engineers.—Omit entirely.

Mr. Hammond, referring to Clause 45 in connection with Clause 44, wanted the provision made more stringent as if the electrical resistance went down to 5,000 ohms with a number of consumers it would cause great trouble. He would propose that the Board of Trade should lay down rules for wiring.

The **Chairman**: We have never gone into private houses, but have kept carefully outside.

Mr. Hammond remarked that a man might say his leakage did not exceed what the Board of Trade allowed and might insist on being connected. The Phœnix rules provided a scale ranging from 500,000 for 25 lights to 125,000 ohms for 100 lights, and so on. He would suggest that an installation should not be connected if the insulation was less than the number obtained by dividing 75 megohms by the number of lamps.

Prof. Ayrton said there should also be the power of cutting off the consumer when his insulation fell below that point.

Mr. Crompton was in agreement with Mr. Hammond.

Major Cardew said that where the insulation resistance had fallen down to such a despicable figure as 5,000, the undertakers should be compelled to cut off.

Prof. Ayrton said there would be danger of difficulty from bad work in houses, because the householder knew very little about the matter. It should be known that unless the work there was properly done, there was no prospect of being connected on. He would support the amended form of the subsequent clause (46A) standing in the name of the Institution of Electrical Engineers.

The **Chairman** said that the proposed amended clause, 46A and B, only empowered the undertakers to do what they could do already. The *raison d'être* of Clause 45 was to make it compulsory to cut off at a certain figure.

Prof. Ayrton said that was like telling a man he had legal power to arrest a thief. He wanted more than that; he wanted a policeman.

Mr. Morse said the power was not contained in the Chelsea order.

Mr. Wordingham said it was the general feeling among contractors that the consumer could insist on being put on at 10,000 ohms.

Major Cardew suggested that the limit might be a leakage of one thousandth of the current supplied instead of the 5,000 ohms limit.

After further conversation, the **Chairman** said Clause 44 must remain and 45 should be accompanied by words providing that the regulation should not affect any power contained in the provisional order to cut off the supply.

Prof. Ayrton said in the city of London they had asked for a limit of 100 megohms divided by the number of points wired, and had often got it.

Sir James Russell (Edinburgh) said that the general feeling of the public was always to work down to the minimum.

Mr. Sayers thought one-thousandth of the current was too low.

After further conversation, **Prof Ayrton** suggested that the figure should be 75 megohms divided by the number of points of taking off current, but it was objected that this would be too high for motors.

Mr. Gunyon agreed that 75 was too high a number. One difficult light might bring the figure down to that.

The **Chairman** said the form of the regulation would be that the undertakers might, but should not, be compelled to cut off at a certain figure, and that they must cut off below another certain figure.

VII.—*Arc Lighting*

(47) All arc lamps shall be so guarded as to prevent pieces of ignited carbon or broken glass falling from them, and shall not be used in situations where there is any danger of the presence of explosive dust or gas.

Institution of Electrical Engineers.—Further information desired as to the application and intention of the regulations comprised under Section VII.

Northern Society of Electrical Engineers.—Add "under the control of the undertakers."

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London Chamber of Commerce.—Add "belonging to and under control of undertakers."

Glasgow Corporation.—The Corporation suggest with respect to Regulations 47, 48, and 49, alterations which the above suggestions would meet.

Westminster Co., Edinburgh Corporation, Aberdeen Corporation, Belfast Corporation, Oldham Corporation, and Sunderland Corporation.—Understand that this is intended to be limited only to arc lamps, both put up and supplied with current by the undertakers in public streets. Question will arise whether the section would apply where a corporation has put up lamps in the streets, while the lamps are supplied with current by a private company. The corporation would in that case apparently not be acting under the Electric Lighting Acts in putting up the lamp-posts. It is also a question whether section would apply to arc lamps in buildings belonging to corporations who are undertakers. If so, corporation buildings would be under regulations which would not apply to exactly similar buildings which are private property, owing to the corporation supplying current. Suggest omission of section.

Bournemouth Co.—If the clause applies only to lamps which are the property of and are maintained by the undertakers, words are required to so limit its meaning. Undertakers should not be made responsible for construction and maintenance of lamps which may be property of consumer and in no way under undertakers' control, nor should they have to decide as to any danger of the presence of explosive dust or gas in the situations in which lamps are to be used.

Bolton Corporation.—Presume that this only applies to public arc lamps, as the undertakers have no control over private arc lamps.

The *Electrician*.—"Nor is this the only blow which the new proposed regulations may possibly direct against arc lighting. In Section VII., paragraph 47, it is provided that these lamps 'shall not be used in situations where there is any danger of the presence of explosive dust or gas.' The expert above referred to, a man of unsurpassed experience in arc light matters, is inclined to regard this regulation as being too stringent because this danger exists in every building where gas is used. We hardly think, however, that it can be the intention of the Board of Trade to prohibit the use of arcs and gas jets in one and the same building. As well lay down a law that no building shall have two or more gas jets, on the ground that one might be 'escaping' while the others were alight."

Phœnix Fire Office.—Are glad this regulation has been drawn up.

Newcastle Co.—Too stringent. There is always danger of gas leaking wherever fitted in a house. The rule might be construed to mean that where gas is used in a building for lighting, etc., arc lamps must not be erected.

(48) Arc lamps used in any street shall be so fixed as not to be in any part at a less height than 10ft. from the ground.

Edinburgh Corporation.—That the regulation as drawn goes beyond the powers of the general Acts, and would apply to lamps on consumers' premises or outside windows, and such lamps, often, cannot be hung so high as 10ft. Suggest that clause be altered to refer in express terms to arc lamps used for public lighting of streets.

Liverpool Co.—No objection if regulation refers only to public lamps for street-lighting. Point out that, by Liverpool Corporation regulations, consumers' arc lamps can now be fixed at 8ft. from the ground, and that to raise them 2ft. would render them useless for their intended purpose—*i.e.*, lighting shop windows.

Burnley Corporation.—If regulation applies to arc lamps for lighting shop windows, submit that "ten" be altered to "seven" feet, the height allowed for gas lamps. If for street-lighting only, words should be inserted in the regulation to that effect.

Bolton Corporation.—Presume that this applies to public arc lamps only, the undertakers having no control over private arc lamps.

Huddersfield Corporation.—If 10ft. applies to lamps used for lighting shop windows, doorways, etc., it is prohibiting the use for such purposes. Usual height, 7ft. 6in.; 10ft. low enough for street lamps.

Halifax Corporation.—This would prevent the use of arc lamps outside shops with low windows. Suggest that the regulation should apply to high-pressure arcs only.

Walsall Corporation.—10ft. should be 8ft.; the height which gas lamps have to be above the level of the footway by general law; 10ft. would probably prevent shopkeepers using arc lamps outside for lighting their windows.

Southport Corporation.—10ft. should be 8ft.; 10ft. would prevent use of arc lamps for lighting outside shop windows. Local Act provides that no projection, sun-blinds, etc., shall project above footpath at less than 8ft. from the ground, and no inconvenience is caused.

Lancaster Corporation.—It is often useless and impracticable to fix arc lamps more than 7ft. or 8ft. from the ground. Suggest that the regulation apply only to high-pressure arc lamps.

Blackburn Corporation.—Lamps have been fixed at less than 10ft. Tenant on ground floor has no right to fix a bracket higher than his own part of the buildings. Arc lamps properly fixed are as safe as gas lanterns.

Wolverhampton Corporation.—Low-tension circuit arc lamps should be excepted.

Bury Corporation.—Arc lamps erected at a height of 10ft. will not meet the requirements of shopkeepers—the height proposed is too stringent, especially as at Bury the system is low pressure.

The *Electrician*.—"The Board of Trade draft of the new regulations and conditions for the safety of the public in the matter of electric supply, which we reprinted and commented upon in our issue last week, will have the effect, if put into force, of considerably modifying at least one branch of electric lighting—to wit, the use of small arc lamps for lighting shop and other exteriors. No one can have failed to notice the rapid and extensive increase of this class of apparatus, and anyone who has compared the relative economy and convenience of small arcs and large incandescent lamps for shop exteriors will probably have discovered the superior merits of the former. But, as has been pointed out to us by an arc lamp expert all this seems likely to be quashed, and the use of arc lamps in this way "in any street" will become difficult if the 10ft. from the ground rule is to be enforced. It is easy to see why large arc lamps, with bulky globes protected only by wire netting, should be placed beyond the possible thrust of a giant's umbrella; but it is not so easy to comprehend why it is that small arcs placed in suitable metal reflecting cases in front of shop windows should be treated more stringently than gas or oil lamps similarly situated."

St. Pancras Vestry.—Clause prohibits use of arc lamps for shop-window lighting where the arc lamp is too often about 8ft. from ground, just clear of a person walking underneath. In street-lighting, average height of gas column is 8ft.; if small arc lamps are used with these columns the height of the arc would not be more than 9ft.

Manchester Corporation.—After "arc lamps" insert "connected to any high-pressure circuit." The regulation as it now stands would preclude the use of arc lamps in many situations outside shops where they are now fixed.

Edinburgh Corporation.—See remarks of Corporation on Regulation 47.

Eastbourne Corporation.—Regulation applies presumably to high-pressure lamps only under control of undertakers. Low-pressure lamps would be fixed by consumer where he liked.

Eight feet, instead of 10ft., was suggested from Liverpool as the minimum height of arc lamps in the interests of shop-window lighting, and this was supported from Taunton and elsewhere.

The **Chairman** said the working limits should be 10ft. for arc lamps for public lighting and 8ft. for private lights, provided these were screened from contact.

(49) A cut-off switch, fixed in a suitable locked receptacle, shall be provided for every high-pressure arc lamp, and such switch shall be of such pattern and construction as will provide (*a*) that the lamp can by its means be entirely disconnected from the supply circuit; (*b*) that the switch itself can be safely operated in the dark by an inexperienced person and without special precautions; and (*c*) that there shall be no danger of any injurious electrical arcing, sparking, or heating being caused by the operation of the switch.

Bolton Corporation.—Presume that this applies to public arc lamps only, the undertakers having no control over private arc lamps.

Birmingham Co.—Suggest "double-pole switch."

Wolverhampton Corporation.—(*b*) Omit reference to "inexperienced person," otherwise Board of Trade sanction operating of a high-tension switch by an inexperienced person, which should not be.

St. Pancras Vestry.—Omit words in paragraph (*b*) after word "dark."

Edinburgh Corporation.—Omit "by an inexperienced person."

The words "inexperienced person" were left out of this clause.

Penalties.

(50) If the undertakers make default in complying with any of the preceding regulations, they shall be liable to a penalty not exceeding £10 for every such default, and to a daily penalty not exceeding £10. The imposition of any penalty under this regulation shall not affect the liability of the undertakers to make compensation in respect of any damage or injury which may be caused by reason of such default.

Greenock Corporation.—That the penalties appear to be excessive.

Northern Society of Electrical Engineers.—Alter £10 to £5, and omit second paragraph.

The **Town Clerk of Hull** called attention to the wording of the clause, which might cause an assumption that the undertakers were liable to make compensation when they should not be, and the **Chairman** said he would consider how to meet the point.

B.—Regulations as to Supply.

(1) One week at least before the undertakers are ready to commence to supply energy through any feeding, charging, or distributing main, they shall serve a notice upon the local authority of their intention to commence such supply.

Notting Hill Co.—Consider that the ordinary notices served on the different authorities of intention to construct new mains should be sufficient intimation of intention to supply energy through such mains, and that to give a further week's notice is unnecessary delay.

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Chelsea Co.—A delay of one week for notice of intention to supply is much too long. Suggest one clear day's notice.
One week was altered to 48 hours.

(2) From and after the time when the undertakers commence to supply energy through any distributing main, they shall maintain a supply of sufficient power for the use of all the consumers for the time being entitled to be supplied from such main; and such supply shall, except so far as may be otherwise agreed upon from time to time between the local authority and the undertakers, be constantly maintained. Provided that, for the purposes of testing, the authority by whom the electric inspector is appointed may give permission to the undertakers to discontinue the supply at such intervals of time, and for such periods as it may think expedient, and that for any other purposes connected with the efficient working of the undertaking, the undertakers may, with the permission of the Board of Trade, discontinue the supply at such intervals of time and for such periods as the Board of Trade may think expedient. Where the supply is so discontinued, notice of such discontinuance, and of the probable duration thereof, shall be forthwith served upon the local authority.

Burton-on-Trent Corporation.—Raise point as to form of regulations. Company *v.* local authority. Mem.—The form of regulations will be adapted to fit case of local authorities who are undertakers.
Dover Co. and County of London Co.—Instead of "as it may think expedient," suggest "as may be necessary."
Newcastle Co.—It seems a loss of time to all concerned having to apply in every instance to the local authority, especially as under Regulation 10 tests have to be made once a week.
The words "or for any other purpose connected with the undertaking" were inserted after "testing."

(3) The system of distributing mains shall be so arranged that in case it becomes necessary to stop the supply through any portion of a main for more than one hour for the purposes of repairs, or for any other reason, the stoppage of supply will in no case exceed in amount a maximum power of 200,000 watts, or extend to the premises of more than 80 consumers; and in the case of every stoppage for more than one hour, reasonable notice shall be previously given by the undertakers to every consumer affected thereby except in cases of emergency.

London County Council.—The maximum power of 200,000 watts is rather large, and might in many cases be reduced.
Dover Co. and County of London Co.—Suggest raising of maximum power to 350,000 watts and number of consumers to 100.

(4) During the whole of the period when a supply of energy is required to be maintained by the undertakers in the distributing mains under the order and these regulations, it shall be maintained at a constant pressure (in these regulations termed the "standard pressure") to be fixed as hereinafter specified, but such standard pressure may be different for different portions of the distributing mains. Provided that the undertakers shall be deemed to have complied with the requirements of this regulation so long as the pressure does not at any point vary more than 3 per cent. from the corresponding standard pressure in the case of a general supply at low pressure, or 2 per cent. in the case of a general supply at high pressure, unless changes in pressure recur so frequently as to cause unsteadiness in the supply.

Manchester Corporation and Northern Society of Electrical Engineers.—Lines 12-14: omit "in the case of a general supply at low pressure or 2 per cent. in the case of a general supply at high pressure."
Prof. Ayrton remarked it was not clear why the difference was made between high and low pressure, and **Major Cardew** said the limits were drawn as tightly as they could be worked to. There was not the same difficulty with the high-pressure system, which had transformers, as with the low.

(5) The standard pressure shall be fixed by the undertakers for every pair of distributing mains, and notice of the amount of such standard pressure shall be given to the local authority before the undertakers commence to supply energy to consumers through such mains, and such standard pressure shall not be altered except by permission of the local authority, and upon such terms and conditions as the local authority may impose, and after public notice has been given during a period of one month, in such manner as the local authority may require, of the intention of the undertakers to apply for permission to alter the same. The undertakers may appeal against any decision of the local authority under this regulation to the Board of Trade, whose decision shall be final.

Northern Society of Electrical Engineers.—Substitute "Board of Trade" for "local authority" in lines 7, 8, and 10.

(6) Before commencing to give a supply of energy to any consumer, the undertakers shall declare to such consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared at any pair of consumer's terminals shall not, except by agreement, be greater than 150 volts or less than 45 volts if continuous, or the equivalents thereof respectively, if alternating, and shall not at any time be altered or departed from except in consequence of any authorised alteration of the corresponding standard pressure. In distribution on the three-wire system the central terminal shall for the purposes of this regulation be considered to form a pair with either of the outer terminals, and similarly for multiple-wire systems, and in the case of a transformation of energy on the consumer's premises the undertakers shall give the consumer the choice of a supply at either of two different pressures, one of which shall be approximately half the other, and in such case the pressure so chosen by the consumer shall be the declared constant pressure.

London County Council.—After "different pressures" in line 17, words "within the above limits" should be inserted.
Dover Co. and County of London Co.—Instead of 150 volts suggest 220 volts.
Institution of Electrical Engineers.—Lines 6-8: omit "than 150 . . . . if alternating," and insert "if continuous, then 300 volts when for purposes of lighting, or 600 volts for other purposes, and, if alternating, then 250 volts for purposes of lighting or 500 volts for other purposes." Support general desire of the profession to use glow and incandescent lamps taking from 200 to 250 volts at their terminals. Line 14: omit all regulation after word "system."
London Chamber of Commerce.—The words "if continuous, or the equivalents thereof respectively, if alternating," should be omitted. Line 14: omit all regulation after word "systems"
Charing Cross and Strand Co.—150 volts should be increased to 200 volts, as 200-volt lamps are now obtainable.
Westminster Co., Edinburgh Corporation, Aberdeen Corporation, Belfast Corporation, Oldham Corporation, and Sunderland Corporation.—For pressure to be raised to 220 volts, 200-volt lamps being, or likely soon to be, largely in use.
Manchester Corporation.—Alter to read "the pressure so declared at any pair of consumer's terminals shall not, except by agreement, be greater than 500 volts, or less than 45 volts if continuous." It is important that they should be able to declare a pressure of 400 volts in cases where the current is used for the supply of large motors, as if they had to supply at 100 volts serious difficulties would arise.
Northern Society of Electrical Engineers.—Alter 150 volts to 500. Omit all after word "systems" on line 14.

(7) The variation of pressure at any consumer's terminals shall not under any conditions of the supply which the consumer is entitled to receive, nor at any time exceed, 4 per cent. from the declared constant pressure, whether such variation be due to the resistance of the service lines or apparatus belonging to the undertakers, or to any action or effect produced by such apparatus, for which the consumer cannot be shown to be responsible, or partly to any variation of pressure in the distributing mains from which the supply is taken.

London County Council.—Variation of pressure allowed might be reduced from 4 per cent. to 3 per cent. if suggestion of Council on Regulation 45 be adopted. After "responsible, or" in last line but one, "wholly or" should be inserted.
Institution of Electrical Engineers.—Line 3: omit "nor at any time." Line 3: after "exceed" insert "continuously." Line 4: omit all words after "pressure."
London Chamber of Commerce.—The words "for unreasonable period" should be inserted after word "exceed" in line 3.
Charing Cross and Strand Co.—With a view to preventing a vexatious application of Clause 8 some short period of time might be added, such, for instance, as is necessary for a good engine governor to act when a load is thrown on or off.
Northern Society of Electrical Engineers.—Line 3: omit "nor at any time." Line 3: after "exceed" insert "for any reasonable time."
Clause 6 awaits the decision of the committee as to what is a low pressure, and in Clause 7 "at any time" was omitted, and the whole of the words after "constant pressure."

(8) If the undertakers make default in complying with any of these regulations as to supply, they shall, subject to the provisions of the order, be liable to a penalty not exceeding £5 for every such default, and to a daily penalty not exceeding £5.

Northern Society of Electrical Engineers.—Alter £5 to 40s.
This passed without observation, as did all the rest.

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Miscellaneous Observations and Objections.

Coventry Corporation.—That mains have been laid and other work done under present regulations, and that it will be a hardship if more stringent regulations are now to be applied to this work.

Bournemouth Co.—Observe that the regulations do not provide specially for the case of concentric mains, or the earthing of outer conductors of concentric mains, and presume they will be adapted to the system used by different undertakers.

Ayr Corporation —That they have only just received and printed their regulations, and protest against the new ones.

British Insulated Wire Co.—Ask if the new regulations are to be made retrospective, "that is to say, is plant which is already now in position to be used if it does not comply with the then regulations?"

Sheffield Co —Regret that no special privileges have been definitely provided for the removal of the current from the mains for a reasonable period for the purpose of joining up new consumers."

VII.—*Arc Lighting.*

London County Council.—A regulation should be added requiring the leads taken up the lamp-posts to be properly secured by means of insulators in the columns, and also providing that the leads should be insulated with special care, and that the material used shall be of the highest quality for the purpose.

Barrow-in-Furness Corporation.—Assume that the regulations refer only to the supply of electricity for lighting purposes, and not in any way to traction.

Cardiff Corporation.—Ask if the regulations are intended to take effect retrospectively and to apply to existing works If so, they will seriously affect Corporation's lighting scheme and put them to considerable expense. Corporation will be prepared to carry out future works in accordance with new regulations. Ask when regulations are to take effect.

Metropolitan Co.—Observations will be embodied in reply of Institution of Electrical Engineers.

Hastings Corporation —Although compliance with new regulations will necessitate the making of considerable alterations by the local company, Corporation consider the regulations desirable in the interests of the public safety.

City of London Co —Concur in alterations to be submitted by the Institution of Electrical Engineers.

Hove Co.—Concur in views to be put before the Board of Trade by Institution of Electrical Engineers.

Kensington and Knightsbridge Co.—Submit the same observations upon the regulations as the Institution of Electrical Engineers.

London Chamber of Commerce.—A note should be added to the effect that these regulations are only applicable to electric lighting provisional orders as distinguished from electric traction The regulations applicable to low pressure only or high pressure only should be distinguished.

Chelsea Co.—The regulations do not appear to have taken into consideration the peculiar circumstances attaching to the use of a continuous-current transformer system in conjunction with motor-generators and secondary batteries

Institution of Electrical Engineers.—The Council have had brought before them the very important question of the connection to earth of one of the conductors of an electric system. This is distinctly prohibited by the Act except in such cases where permission of Board of Trade has been given. Considerable disappointment has been felt that no mention is made of this subject in the draft regulations under consideration, but it was felt that the subject was a far too important one to be dealt with in the short time which the Council has had at its disposal.

Institution of Electrical Engineers.—That one effect of the new regulations will be to introduce automatic cut-outs, fuses, etc, in the mains, for various purposes Institution object to this method of endeavouring to secure safety. Consider that such appliances should be confined to central stations, sub-stations and consumers' premises, and not placed in boxes underground. Submit that on several points the proposed regulations have been drafted too exclusively with a view to matters concerning the public safety, and that the "ensuring of a proper and sufficient supply of energy" has been to some extent lost sight of.

Edinburgh Corporation.—Submit, with respect to corporation undertakings, that the regulations should be made subject to any relaxation which on representation to the Board of Trade corporations might desire to have made, if they should at any time find it necessary or convenient in the public interest to have such a modification, without having to resort to the making of new and additional rules. Refer to relation of Corporation with respect to interests of the public, and hope that Board of Trade will differentiate the case of corporations from that of companies, by providing that the regulations may contain a power to the Board of Trade of modification on any incidental points at any time arising which might be granted in the discretion of the Board on the application of a corporation who are undertakers.

Eastbourne Co.—That the regulations as drafted would operate hardly against companies, and hope that they will be so modified that, while securing the safety of the public, they may not occasion companies which have been established for a long period, and have worked with great care and without accident, a heavy outlay to comply with them.

The proceedings concluded with a vote of thanks to the Chairman, moved by Alderman Gibson, of Manchester, and seconded by Alderman Myles, of Bolton.

LEGAL INTELLIGENCE.

THE NEW BRITISH ELECTRIC INSTALLATION CONTRACTORS.

The public examination of the directors and officers of the New British Electric Installation Contractors, Limited, under the Companies Winding-up Act, took place last week at the Worcester County Court before the judge, Sir Richard Harington. Mr. Warren Tree appeared for Mr. Millington and other directors and officers, and Mr. Halford for Mr. J H. Martin, a director. The examination was conducted by Mr. Luke J. Sharp (official receiver).

Mr. W. J. Hill, secretary of the company, said he was a clerk in the employment of Messrs. Griffiths and Millington. The signatories to the memorandum of association were Messrs. S. T. Castle, A. H. Parker, J. S Cook, R. J. Surman, A. Usher, W. H. Walter, and J. Duce. These signatures were only obtained to register the company, and none except Mr. Duce and Mr. Surman took any interest in the company. The company was largely promoted by Messrs. Griffiths and Millington. It was necessary that someone should be appointed secretary, and he supposed his name was as useful for that purpose as anyone else's. He had no salary, and had not kept any books, or been engaged at the offices of the company in any way. He kept the register of members and the share ledger, but nothing beyond that. During the first part of the company's existence the arrangement was that Mr. Duce, the secretary of the old company, was to keep the books. The new company was registered on October 29, 1892, the nominal capital being £25,000. A prospectus was drafted, and some 50 000 or 60,000 copies were circulated. Mr. Millington (chairman) and Mr. Duce (general manager and secretary of the old company) were the promoters of the company. Of the names of the directors appearing on the prospectus of the new company, Mr. Alfred Dickinson, Mr. Poulton, and Mr. Wheatley never took a share, and their names did not appear in the books of the company afterwards as being connected with it. The prospectus was made as attractive as possible to the public.

The **Official Receiver**: You were to put electric launches on the Severn?

Witness: That was one of the ideas.

The **Official Receiver**: Was one ever ordered?

Witness: No.

Mr. Hill, continuing, said the prospectus was extensively advertised in the Worcester papers. Notices about it appeared, and the witness admitted that a paragraph in one paper (produced) extolling the prospects of the company, was in his handwriting. There were some small sums subscribed by the public, but they were returned. The business was, however, carried on. Mr. Hill admitted that he had written to the official receiver stating that the value of the assets at that time, apart from the book debts, was £1.000, but a great deal of money and time had been expended by the old company in forming what was thought to be the nucleus of a flourishing concern. In the first place, £5,000 was to be paid for the assets of the old company, but after the failure to form the new company, the price was reduced to £3,000. The business was carried on as usual, and the directors in October, 1892, were Messrs. J. Millington, R. J. Surman, and J. H. Martin. These gentlemen were registered at that time as shareholders, but as a matter of fact the company did not proceed to allotment until February, 1893 Mr. Millington was registered as holding 47 shares of £5 each, the money for which was paid by Mrs. Duce, for whom Mr. Millington acted as trustee. Mr. Surman resigned in February of the present year. The £3,000 for the old business was to be paid by 6 per cent. debentures, to be redeemed by the operations of the company, so that the new company was to pay the debts of the old one. There was no power to issue debentures without a general meeting. This was done at a meeting in February or March, when Messrs. Millington, Duce, Martin, and himself were present. At that time the shares were registered, but the certificates were not issued until January, 1894. In reply to Mr. Sharp, Mr. Hill admitted that the debenture-holders had seized goods supplied by new creditors, and there was no probability of the debentures being paid unless the company was successful, or goods seized which were on the premises. Continuing, he said the debentures were allocated as follows: Messrs. Griffiths and Millington £1,400, Mrs. H. Duce £400 and £650, Messrs. Millington and Perry (trustees for Mrs. Duce) £425, Mr. R. J. Surman £125. The old company was in existence 12 months only, and during that time there was a loss, as shown by the balance sheet issued on January 31, 1893, of £2,000. During that 12 months £500 was allotted for services, and by the issue of the debentures the debt of £500 became a secured debt to the debenture-holders. The debenture-holders did not take shares in the new company. There had been no audit of the company's accounts. After the failure to float the company, an arrangement was made for Mr. Duce and Mr. Martin to supply £250 each, and to carry on the company as a private one. No money was paid to the directors for salary. There had been nothing paid to the debenture-holders. No promotion money was paid. The promoters and managers had been very heavy losers, to the extent of over £3,000. Of this, Mr. Millington had lost £1,300 or £1,400—this was actual cash lost—and Mr. Martin was a loser to the extent of about £800.

Mr. R. J. Surman, surgeon-dentist, Foregate-street, was also examined, and said for his £100 advance to the old company he received a debenture for £125 on the assets of the new. The debenture-holders had taken possession of all the assets of the company.

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Mr. J. H. Martin, 37, Arboretum-road, now out of business, formerly manager of the Worcester Tramway Company, **Mr. James Duce**, electrical engineer, Denganwy. Llandudno, and **Mr. John Millington**, auctioneer and accountant, and chairman of the old and new British Electrical Company, were then examined, and Mr. Millington produced a balance-sheet, the only one he had been able to obtain from Mr. Martin, in March last, which showed that, excluding the shareholders and debenture-holders, the company was solvent. The assets and book debts amounted to £1,047. 16s. and the assets in stock to £640 15s. 4d Exclusive of the share and debenture holders, the liabilities amounted to £840. 11s. 7d., leaving a balance of £847. The old company, however, could not have been carried on without fresh capital being introduced.

The examination was adjourned until December 18.—*Worcester Herald.*

CROMPTON ELECTRIC SUPPLY COMPANY OF AUSTRALIA.

Mr. Justice Kekewich was asked on Tuesday, in a debenture-holder's action, to extend the time during which the receiver and manager of the Crompton Electric Supply Company of Australia might act. His Lordship said that, having regard to the very large number of companies now under supervision, it was important that there should be reality about the receiverships and manager-ships sanctioned by the Court. He declined to treat these matters *pro forma*, and would insist on being satisfied in each case that it was reasonable to continue the appointment. Counsel stated that the plaintiffs in the present case were the holders of £10,000 worth of debentures out of a total issue of £20,000. Negotiations were proceeding for the sale of the company's business, which it was hoped would be satisfactorily completed, and in the interests of all parties it was desirable to continue the receiver and manager for a short time further. On this statement his Lordship continued the appointment until April 30.

COMPANIES' MEETINGS AND REPORTS.

ELMORE'S PATENT COPPER DEPOSITING COMPANY, LIMITED.

A special meeting of this Company was held last week at the Company's works, Hunslet, when the following resolutions, passed by the shareholders at the annual meeting on the 1st inst.. were unanimously confirmed: "(1) That the board of directors may borrow money for the purposes of the Company's business to the extent of £100,000, subject to the provisions of Article No. 46 of the Company's articles of association, except so far as such article may be modified by this special resolution." "(2) That the ordinary share capital of the Company, which now consists of £182,390, divided into 91,195 ordinary shares of £2 each, all such shares being fully paid up, be reduced to £91,195, divided into 91,195 ordinary shares of £1 each, all fully paid up; and that such reduction be effected by cancelling paid-up ordinary share capital, which has been lost or is unrepresented by available assets to the extent of £1 per share on each £2 ordinary share."

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bucharest.—The Administration of the Roumanian State Railways invite tenders by November 30 for the supply of 12,000 porcelain insulators.

Betanzos.—Tenders are invited by December 28 for the concession of the electric lighting for 25 years of the town of Betanzos, Spain. Conditions of La Direccion General de las Administraciones Locales, Madrid.

London, S.W.—The Secretary of State for India is prepared to to receive tenders for caissons, air-compressing and electric light plant. Particulars are to be obtained from the Director-General of Stores, at the India Office, S.W., and tenders must be delivered by December 10.

Manchester.—The Corporation invite tenders by 10 a.m on December 2 for the supply and erection complete of two dynamos at the Foreign Animals Wharf, Mode Wheel. Particulars may be obtained at the city surveyor's office, Town Hall, Manchester, on deposit of one guinea.

Belfast.—Messrs. P. and F. M'Glade invite tenders for supplying and fixing an electric plant for lighting their new premises, The International, corner of York-street and Donegall-street. Copies of specifications can be had, and plans inspected, on application to Messrs. George Coombe and Co., consulting engineers, Castle-lane-place, Belfast.

Brussels.—The Ministère de la Guerre invites tenders by January 15 for (1) a heating installation, (2) electric lighting in the new military school to be constructed in the Avenue de la Renaissance, Brussels.—The Administration des Télégraphes require tenders by December 18 for the supply of various large lots of pine telegraph poles. Special cahier des charges No. 26 at the Brussels Bourse.

Leicester.—The Corporation invite tenders for the supply and delivery of the necessary cast-iron pipes and connections, from 2in. to 24in, in diameter, required during 12 months ending December 31, 1896, for the Gas and Electric Lighting Committee. Specification and form of tender to be obtained from Mr. Alfred Colson, M.I.C.E., engineer and manager, Millstone-lane, Leicester. Tenders, addressed to Alderman Lennard, chairman, and endorsed "Tender for Cast-Iron Pipes, etc.," are to be delivered by 11 a.m. on December 7.

London, N.—The Great Northern Railway Company invite tenders for the supply of new and the purchase of old stores for 12 months from January 1. A list of the contracts and separate forms of tender for each contract may be obtained upon application to Mr. Martin, the stores superintendent, Doncaster, by whom every information will be furnished, and the patterns of telegraph and electric lighting material will be exhibited at the telegraph stores, Retford. Tenders, addressed to the Stores Committee, marked on the outside with a description of the stores tendered for, must be sent to the company's offices, King's Cross, in the envelopes specially provided, so as to be received by 10 a m. on December 7. Mr. William Latta, secretary, King's Cross Station, London, N.

Swansea.—The Corporation invite tenders for the following works: Contract No. 1: For the supply and erection of destructor and electricity supply station buildings complete, including engine and destructor houses, offices, approach roads, and yards. Contract No. 2: For the erection of a chimney shaft, 150ft. in height, with all necessary foundations and accessories. Contract No. 3: For the supply and erection of a dust destructor, including eight destructor furnaces, and four water-tube boilers, with all flues, dampers, and accessories necessary to the satisfactory setting to work of the same. Specifications, bills of quantities, and forms of tender of the engineers, Messrs. Kincaid. Waller, and Manville, 29, Great George-street, Westminster, S.W., for £3. 3s. each specification. The plans can also be seen at the offices of the engineers or at the Guildhall, Swansea. Sealed tenders are to be sent to Mr. Jno. Thomas, town clerk Guildhall, Swansea, endorsed "Swansea Dust Destructors and Electricity Supply—Tender for Contract No. 1, 2, or 3," as the case may be, at or before 4 p.m. on December 6.

RESULTS OF TENDERS.

London.—The following were the tenders for electrical work at the Metropolitan Asylums Board's Brook Hospital:

	A.	B.	C.
Siemens Bros. and Co., Woolwich	£2,004	£527	£475
W. H. Allen, Son, and Co., Bedford	2,060	—	—
J. H. Holmes and Co., Newcastle-on-Tyne	2,100	350	475
Crompton and Co., Chelmsford	2,139	366	551
Electric Construction Company, Wolverhampton	2,142	370	509
Johnson and Phillips, Charlton	2,170	630	360
T. Parker, Limited, Wolverhampton	2,312	412	521
Brush Electrical Engineering Company, Limited	2,428	480	378
Mather and Platt, Salford	2,605	415	465

A. Engines, dynamos, etc. B. Switchboards, etc. C. Batteries, etc.

Subject to the assent of the Local Government Board, the tenders of Messrs. Siemens Bros. and Co. for the engines, dynamos, etc., at £2 004, and for the batteries, etc., at £475, and the tender of Messrs. J. H. Holmes and Co. for the switchboards, etc., at £350, were accepted. The tenders for the wiring work and fittings, etc., at the Brook Hospital and Ambulance Station were as follow:

	Brook Hospital.	Brook Ambulance Station.
Electrical and General Engineering Company, 86, Leadenhall-street	£3,169 10 0	£289 0 0
Brush Electrical Engineering Company, Limited, 49, Queen Victoria-street	4,547 0 0	192 0 0
J. Sax and Co., Limited, 7, Ridgmount-street, W.C.	4,666 8 4	213 9 11
Fowler, Lancaster, and Co., Birmingham	4,685 12 6	228 0 0
Edmundson's, Limited, Westminster	4,643 19 0	350 15 0
Strode and Co., Regent's Park	4,878 0 0	334 0 0
Pritchetts and Gold, Soho-square	5,279 10 0	289 0 0
C. Nathan, Victoria-street, S.W.	5,063 0 0	630 0 0
H. F. Joel and Co., Finsbury-square	5,954 0 0	336 0 0
Hollingum and Saword, Holborn Viaduct	6,179 0 0	400 2 6
Slaters, Limited, Kensington	6,217 0 0	534 0 0

The tenders of Messrs. Julius Sax and Co., Limited, were accepted.

Glasgow—The Corporation have accepted the offer of Mr. Richard Miller to supply an electric light installation for the Family Home in St. Andrew's-street at a cost of £312.

Mitcham.—The tender of Messrs. Gray and Son, Leadenhall-street, for the erection of a lightning conductor on the water-tower at Mitcham Workhouse, for the Holborn Board of Guardians, has been accepted.

Killarney.—The tender of Mr. Chas. Leigh Clarke, of the Northern Counties Electric Construction Company, of 7, South-parade, Manchester, for the erection of an electrical installation as per specification at the Killarney Lunatic Asylum at the cost of £1,555, has been accepted.

Barnsley.—The Stafford Main Collieries Company, Limited, near Barnsley, having decided to have their collieries fitted with the electric light, the order has been placed with Messrs. A. Hirst and Son, of Crescent Works, Dewsbury. The plant will consist of a 600-light slow-speed dynamo and about 300 lamps.

Worcester.—The Town Council have authorised the purchase from the Brush Company of one 18-kilowatt transformer at £58. 16s. and sundry stores at £2. 10s. 3d., and also the acceptance of the tender of Messrs. Korting Bros., of 53, Victoria-street, London, to

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provide and fix a condensing plant at the Powick generating station, in accordance with specification, at £430.

Paris.—For supply to the Direction Générale des Postes et des Télégraphes, Paris—(1) 6,000 iron cross-pieces with galvanised accessories, Mme. Vve Silvert Levent et Cie, à Bavay (Nord), 17,620fr. (accepted); (2) 12,000 ditto, same firm, 32 328fr.; (3) 9,000 ditto, Société de Gorcy, 25,191fr. (accepted); (4) 8 000 head cross-pieces, same firm, 23,072fr.; (5) 12,000 U consoles 12,000 long U cross-pieces, and 10,000 double iron consoles, MM Boucha-court et Cie, Paris, 31,490fr. (accepted); (6) 50,000 long consoles, Mme. Vve Silvert-Levent et Cie., 38,500fr. (accepted); (7) 50,000 ditto, Société de Gorcy, 38,800fr. (accepted).

BUSINESS NOTES.

Hawkshead (N. Lancs.).—The Parish Council have discussed the electric light question.

Western and Brazilian Telegraph Company.—For the past week the receipts were £3,049.

Lynn.—The Town Council have decided to obtain a provisional order for the electric lighting of the town.

Dover.—The electric lamps on the arches in Snargate-street were officially lighted for the first time on Saturday last.

Stroud (Gloucester).—A telephone exchange in connection with the National Telephone Company's system has been opened.

Douglas (Isle of Man).—The exhibition buildings, including the electric plant, at Bellevue, Douglas, have been completely destroyed by fire.

Leipzig.—The electric light, the *Gas World* says, has been succeeding beyond expectation in Leipzig. The orders amount to the equivalent of 31,500 16-c.p. lamps.

Berlin. -- The Grosse Berliner Pferdeeisenbahn Gesellschaft (horse tramway company) has submitted to the Magistracy various proposals for electric traction on its lines.

Societe Commercial Belge Gaz et Electricite —The ordinary general meeting of this Company will take place on December 11 at 22 rue des Palais, Schaerbeek, Brussels.

Nesten (Cheshire). — At a second meeting of ratepayers called by the District Council, it was resolved that the Council should go fully into the question of the cost of electric lighting and report on the subject.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended November 24 amounted to £1,067, as compared with £913 in the corresponding week of last year, being an increase of £154.

Wakefield.—The Corporation having applied for powers to borrow £25,000 on loan to defray the cost of the proposed electric lighting works, a Local Government Board enquiry is to be held on the subject to-day (Friday).

Catalogues etc.—Messrs. J. H. Heathman and Co. of 2 and 37, Endell-street, London, W.C., have forwarded us a copy of their illustrated price-list of extension ladders and steps, trolleys, fire-escapes, hose, garden engines, pumps, etc.

Queenstown.—The Queenstown Town Commissioners intend to apply to the Board of Trade for a provisional order under the Electric Lighting Acts, 1882 and 1888, to authorise the Commissioners to produce electricity for public and private purposes.

Russian Company for the Exploitation of Electric Energy.—With this translated title a company has been formed in St. Petersburg with a capital of 500,000 roubles. It proposes to erect a large central station near the Katharine Canal.

Shrewsbury.—In reference to the proposal for the electric lighting of the parish church, a vestry meeting has determined to reconsider the whole question in six months' time, with the view of introducing the new system for the winter of 1896.

Cheltenham.—The Town Council have decided to promote a Bill for the purchase of the gasworks, Alderman Vorman, the chairman of the Lighting Committee, citing many instances in which gas and electric lighting were running prosperously side by side.

Dublin.—A recent number of the Dublin *Evening Telegraph* contains a sketch map of the proposed important system of electric tramways in that city to cost about £300,000. The directors of the Dublin and Southern Electric Tramway Company are applying to Parliament for the necessary powers.

City and South London Railway.—The returns for the week ended November 24 were £946, compared with £957 for the corresponding period of 1894, being a decrease of £11. The total receipts for the half-year 1895 are £18,562, compared with £18,648 for the corresponding period of 1894, being a decrease of £86.

Cooper Bros. and Sons, Limited.—This Company has been registered with a capital of £40,000 in £10 shares. Object: to enter into a certain agreement for the acquisition of the business of Cooper Bros., now carried on at the Don Plate Works, and to carry on the business of electroplate and cutlery manufacturers in all its branches.

Brazilian Submarine Telegraph Company.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended September 30 last, payable on December 20. The transfer books of this Company will be closed from December 13 to December 19, both days inclusive.

Davy Electrical Construction Company, Limited.—This Company has been registered with a capital of £10,000 in £1 shares. Object: to enter into an agreement with W. J. Davy, and to work and turn to account all or any of the properties by the said agreement agreed to be sold to the Company. The directors are W. T. Douglass, E. Berthier, and W. J. Davy.

Coops and Co., Limited.—This Company has been registered with a capital of £5,000 in £1 shares. Object: to enter into a certain agreement for the acquisition of the business of an india-rubber merchant and manufacturer, etc., as hitherto carried on by Charles Coops, at Duke-street, Liverpool, under the style of Coops and Co., and to develop and extend the same.

Portsmouth.—The Provincial Tramway Company are moving for parliamentary powers to use electricity as a motive force over the whole of its system at Portsmouth. The current is to be conveyed by overhead wires, and permission will be asked by the company to erect generating stations at each end of the town, and to use the electric current supplied by the Corporation.

Calne (N. Wilts.).—The District Council have discussed the question of adopting the electric light. A member said that if such a little place as Keynsham, with about 1,500 inhabitants, could afford to have the electric light, surely Calne might venture to do so. The existing gas lighting was described as "simply shocking." The matter was eventually referred to the Lighting Committee.

Bristol.—The clerk to the St. George Urban Council has announced that he had received copies of the Board of Trade regulations respecting the use of electrical power on the tramways. The regulations had been framed with the view of protecting the public against possible danger, and fixed the maximum speed of the cars at eight miles an hour, while at some junctions it must not exceed four.

Llanelly.—It is stated that the provisional order for the lighting of the town by electricity which was obtained by the Borough Council, has been purchased by Messrs. J. C. Howell, Limited. The Council authorised the Finance Committee to negotiate with Mr. J. C. Howell, managing director of the firm, and it is said that terms have now been arranged which will meet with the approval of the Council.

Lambeth.—A special meeting of the Vestry has been held. It was called by requisition to consider a motion moved by Mr. Bennetts, and which had been adjourned from a previous meeting, "That a special committee of 11 members be appointed to consider carefully all the information obtainable on the electric lighting question and report thereon to the Vestry." After a long debate the resolution was carried.

Apostoloff Automatic Telephone Parent Syndicate, Limited. This Company has been registered with a capital of £10,000 in £1 shares. Object: to acquire any patents, patent rights, etc., relating to improvements in telephones, and, in particular, an invention known as the Apostoloff automatic telephone, and to develop and work the same. The directors are M. Margowski, J. W. Cohen, and T. S. Hopcraft.

Gloucester.—With reference to electric lighting, regret has been expressed in the Town Council that it was proposed to light only a small area in the centre of the city, and the Mayor explained that the minimum distance had been purposely stated in the preliminary notice, as after the provisional order had been obtained they could, if they desired, extend it to the limits of the city. This was accepted as satisfactory, and the minutes were confirmed.

Bournemouth.—The Public Lighting Committee have received a notice from the electric supply company stating that a continuous supply of electric energy on all mains throughout the 24 hours would be given shortly. The Town Council adopted the report and also a number of recommendations for altering the position of public lamps and adding to the number of lamps in several districts where the lighting was considered insufficient at present.

Bermondsey (London).—The Vestry have decided to inform the Board of Trade that they intend to oppose the application of the Capital and Counties Electricity Supply Company for a provisional order for the lighting of the parish by electricity. It does not appear that the Vestry are desirous of undertaking the work itself, but that form of proceeding was the only way to get a copy of the order, so that the Vestry might see that the clauses did not injuriously affect the district.

Leith.—A deputation of the Leith Town Council have visited Glasgow for the purpose of inspecting the Johnston motor car. The deputation were appointed to visit Glasgow and see the car at work, in view of the application by the Edinburgh Street Tramways Company to use this new motor on their system. The motive power is "high-pressed superheated steam produced by means of special oil fuel, which is fed automatically to the generator." The deputation are said to have been "highly pleased with what they saw."

North Walsham (Norfolk) —The clerk to the District Council has read some correspondence with the Norwich Telephone Company as to the additional poles they wished to erect in the town to connect Mr. Reeve's house and his granary at the Great Eastern Station to the existing wires, and reported that, according to their contract, the wires, which should be 30ft overhead according to the measurements taken by the surveyor at different places in the town, were fixed at different heights, varying from 15ft. to the height named It was resolved that the Council should not entertain their application until the company had fixed the existing wires according to their contract.

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Vienna.—The Gemeinde has received eight offers for the construction of electric railways in Vienna: (1) Eduard Lachmann, Hamburg; (2) Adolf Springer, Vienna; (3) Kontinentale Gesellschaft für elektrische Unternehmungen, Nürnberg; (4) Allgemeine Elektricitäts-Gesellschaft, Berlin; (5) Wiener Bankverein; (6) Neue Wiener Tramway-Gesellschaft, with the Anglobank and Siemens and Halske, Vienna; (7) Bauunternehmung Ritschel und Comp, Vienna, with the Union Elektricitäts-Gesellschaft, Berlin; (8) Stadler Stephan, Neupest.

Glasgow.—The new portion of the post office, which has been under construction for several years, has now been finally opened. The new plant for supplying electric energy and lighting the building has been erected in the basement of the new block There are three 80-i.h.p. engines of the Willans central valve type, suitable for a steam pressure of 120lb. to the square inch. The dynamos are mounted on the engine frame, and are of Crompton's make. The output of each machine is 465 amperes at a pressure of 108 volts, and at a speed of 450 revolutions per minute

Telegraphic Extension in Ross-shire.—Mr J G Weir, M P. for Ross shire, has been in communication with the Scottish Office regarding telegraphic extension to the poorer districts of Ross-shire with local guarantees, and has received a reply from Lord Balfour of Burleigh stating that the application will be considered along with others in the event of a grant for telegraphs being included in next year's estimates for public works in the Highlands, but adding that the Secretary for Scotland cannot guarantee that it will be found the most urgent case.

British Electric Traction (Pioneer) Company, Limited.—This Company has been formally registered with a capital of £100,000 in £10 shares. Object: to adopt and carry into effect an agreement expressed to be made between the Electric and General Investment Company, Limited, of the one part and this Company of the other part, and to carry on business as carriers of passengers and goods, electricians, engineers contractors etc The directors are Sir C. R. Wilson, Earl of Suffolk and Berkshire, J S Raworth, and E. Garcke Registered office: 1 and 2, Great Winchester-street, E.C.

Londonderry.—The resident electrical engineer (Mr. J. Christie) has reported to the Lighting Committee on the cost of proposed alterations and new lamps. The cost of having a new electric lamp erected in Marlborough-street would approximately be £72. 15s. The change in the position of an electric lamp at Mr. John Doherty's factory, Abercorn-road, would cost £5. 12s 6d. The cost of improving the lighting at the Synod Hall and other places in the city, about which reports were received, was also estimated. Alderman Miller complained of the light being turned off at midnight.

Electric Railways in Japan.—Application has been made to the Japanese Government for a charter for an electric railway connecting Yokohama with Fujisawa, touching *en route* at Kamakura, Shichiriga-hama, and Enoshima, the whole distance being 17 miles 42 chains. The gauge of 4ft 8in. is to be adopted, the speed will be 30 miles per hour, and trains are to leave both termini every 15 minutes. There are several projects for laying electric tramways in Tokio, the Japanese capital. Negotiations for amalgamation are proceeding between two of the principal companies, and hopes of success are entertained.

British Motor Syndicate, Limited.—This Company has been registered with a capital of £150,000 in £1 shares. Object: to adopt and carry into effect a certain agreement, the parties to which are not mentioned; to use, exercise, develop, grant licenses in respect of, or otherwise turn to account, any patents, licenses, concessions, and the like; to manufacture and deal in motors of every description, cycles, carts, wagons, ships, boats, launches, flying-machines, and carriages of all kinds; as electrical and mechanical engineers, machinists, fitters, metal-founders, millwrights, smiths, wire-drawers, tube-makers, metallurgists, saddlers, rubber merchants, etc.

Hornsey (Middlesex).—The County of London and Brush Provincial Electric Lighting Company, Limited, have written to the Hornsey District Council proposing to light the public thoroughfares of the parish. Mr. Bell thought the Vestry, when they had their wharf and dust destructor finished, might provide their own light, that was supposing they had not given up their rights in the matter. The Chairman replied that the parish had not given up any rights in the matter. It was probable when the apparatus was fully established in the parish they might have an installation at the Vestry Hall, but he could not say anything definite on the point just then.

Rockhampton Electric Lighting Company, Queensland.—The following is an extract from a letter received from this Company by their agents, Messrs. Wm. Coward and Co, of 27, Leadenhall-street, London, E.C.: "Through the medium of the electrical journals I have been watching the rapid growth of the electric light industry and its effect upon the gas enterprise. The keenest possible attention appears to be given by both sections of English lighting companies to everything calculated to further their interests. If there are any special features in connection with the commercial policy adopted by these companies which you consider might work favourably out here and likely to commend themselves to my directors, I shall be glad if you would refer to them for their consideration."

Camberwell (London).—The General Purposes Committee of the Camberwell Vestry have recommended that the consent of the Vestry be given to the application of the County of London and Brush Provincial Electric Lighting Company, Limited, for a provisional order for the electric lighting over the whole of the parish, with he exception of that portion of the parish over which the Crystal Palace Lighting Company have powers. An amendment was, however, carried, which stated "that the assignment of a monopoly of electric lighting in this great and growing parish to a private company for so great a period as 42 years demands such grave consideration that the Vestry hereby appoints a special committee to consider and report upon the question of the electric lighting of the parish in all its bearings."

Newport (Mon.).—It has been determined to extend the area of electric lighting in Newport by laying mains in Cambrian-road, Fields Park-road, Fields Park-crescent, Bryngwyn road, Godfrey-road extension, and Fields-road extension. This extension will cost nearly £1,000. It has also been determined to supply electric current to private consumers during the day, and to switch out the arc lights in the principal streets at midnight. A complete report as to the cost of the electrical installation has been ordered to be prepared, with the idea of applying to the Local Government Board for sanction to the borrowing of the necessary money over and above the £28,000 already sanctioned to cover the cost of additional works, etc. The street and private installations, as far as they have gone, have proved a complete success.

Wells (Somerset).—The Sanitary Committee have reported, as the result of their negotiations with the gas company, that the latter had offered the works to the Council for £19,680, which the committee considered out of the question. The committee were prepared to recommend the Council to give a sum of £12,700, which they considered the value of the undertaking. This sum the company had declined to accept, and as they offered no alternative nor accepted the offer to light the city, negotiations as far as the committee were concerned were at an end. The Council consequently have formally resolved to apply to the Board of Trade for a provisional order to light the city with electricity, and £50 has been voted to deposit with the Board of Trade, a proposition to offer the gas company £15,000 for their concern being rejected.

Holyhead.—A correspondent writes: "I discover the following is the extraordinary situation of the Holyhead Pier Station, where all the mails and most of the important passenger traffic between England and Ireland pass four times daily. Distant more than a mile from the fine harbour station, there are neither telephonic, nor telegraphic, nor acoustic nor any means of communicating between the two points. Last year, I was told the engine that had to push the train up from the pier being in the rear, nearest the sea, a leading carriage derailed at the points. The officials in Holyhead could not be informed of this (nor can they now be informed of any the most frightful disaster on the pier) until a porter could walk up the line in the dark. It may be against a hurricane and driving rain or snow. Such a fact at this date might seem altogether incredible."

Tramways Construction Company, Limited.—This Company has been registered with a capital of £100,000 in £10 shares. Object: to enter into certain contracts for the construction, repair, and maintenance of, and to construct, equip, repair, and maintain, under contract or as owners, tramways and other roads or ways (to be used for traction by electricity, steam, or other agency), bridges, subways, sidings, waterworks, etc, including the laying of pipes for distribution; buildings of any kind; telegraphs and systems of telephonic communication or electric lighting; and to work and carry on, under contract or as owners, or otherwise, any electric or other tramways, etc. The signatories are: H. R Beeton, 6A, Austinfriars; J. B. Concannon 28, Austinfriars; W. Hadenstein, H. W. Jefferson, H. Oppenheim, J. Morris, H. Marnham. Registered office: St. Michael's House, St. Michael's-alley, Cornhill, London.

Ipswich.—On the minute recording the interview with Mr. Paris on behalf of the County of London and Brush Provincial Electric Lighting Company coming up for confirmation, the Town Clerk informed the Paving and Lighting Committee that he had received a letter apologising for delay and saying that the manager had been ill. The Mayor said the matter had not been referred by the Council to this committee and they really had no jurisdiction in it. The Town Clerk said he had received from the company a map showing the compulsory area they proposed, and he found it did not include anything like all the streets the Council on a former occasion decided should be included in the area in which it should be compulsory on the company to supply electric light. It did not include Mr. Pratt's premises. He returned it and pointed this out, and the company replied that once more there had been an error.

Wilmslow (Cheshire).—The District Council have received a letter from Mr. S V. Clirehugh, electrical engineer, Manchester, with regard to the question of electric lighting in the district. Mr Clirehugh's letter stated that an agreement had been entered into between the Alderley Edge District Council and himself to transfer the powers which had been conferred upon that Council to a company, of which he was engineer, and that the company were anxious to obtain powers, subject to the control of the Wilmslow Council, to supply electricity in the Wilmslow town and district. They were anxious that no delay should occur, and he suggested that a committee should confer with him on the subject. They would, if possible, apply at once to the Board of Trade for a license, so that the electric light might be available for next winter. After discussion a committee was appointed to meet Mr. Clirehugh.

City of London Electric Lighting Company, Limited.—The directors announce the issue, at a premium of 28 per cent., of £100,000 5 per cent. debenture stock, being the balance of an authorised total of £400,000, redeemable at 125 per cent., on six months' notice, after 1910, and secured by a first charge on the

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whole undertaking, subject to certain restrictions. The Company was formed in 1891, and has a fully-paid share capital of £800,000. The total expenditure on freehold and leasehold land, machinery, buildings, plant, etc., amounted at June 30 last to £1,078,684; and, on the same date, stores, cash at bankers, investments, and other assets represented £130,938. The gross income, as shown by the published statement of accounts, was for 1893 £39,663, and for 1894 £68,864; whilst for the nine months ending September last the revenue came to £60,390. The list of subscriptions opened yesterday, and closes to-day for both town and country.

Newcastle.—There is considerable opposition to the Town Council's plan of leasing the tramways which would commit the town to the adoption of the cable system for the next 21 years. Another meeting has been held in furtherance of the campaign of protest against the Corporation's settlement of the tramways scheme. There is now some talk of carrying the opposition to Parliament. Mr. J. G. Cranston, of 24, Grey street, is acting as secretary to the opposition movement. An elaborate printed statement has been issued giving the facts and figures on which the opponents of the Corporation's scheme rely. In this statement it is argued that the reconstruction will cost the ratepayers £230,000, while the monopoly of working the trams is to be given away to a private company who will have a concession worth £50,000 put into their pockets and the chance of earning 40 per cent. on the capital required to work the lines. The writer of this statement pins his faith to the electric as being better than the cable system proposed.

Feltham (Middlesex).—A meeting has been held in the Public Hall to discuss the question of introducing the electric light into the village. Mr. Quihampton opened the meeting by reading a copy of a circular which had been distributed: "Proposed Electric Lighting for Feltham.—We, the undersigned, think it desirable that electric lighting should be introduced into the village, and as a commencement to take in from the railway bridge to the Water Splash. From the estimates already received, we are of opinion that the price would compare very favourably with the present system of lighting. Both for private and business purposes, the electric light is unequalled, giving neither trouble nor dirt. The estimated cost, including working expenses for about the first three months, would be upwards of £1,000, of which sum half has already been promised." In the end, the Chairman stated that Mr. Holland would be glad to give his services as secretary to a proposed company, and it was agreed that someone should call upon those interested in the subject to try and get them to take shares.

Brighton.—A correspondent writes: "Although the great extension of electric lighting in the main thoroughfares of Brighton, inland as well as on the entire sea-front, will not be in complete working order until early next year, some of the streets will have the benefit of the new system before the scheme is realised in its entirety. Queen's-road, for instance, has been so illuminated since a few days ago, and coming at a time when the visiting population is greatly augmented on account of the conference of the National Conservative Union, the innovation will serve a useful purpose in demonstrating to visitors on their way to and from the station that the enterprise of the Corporation is not limited to the front-line alone. No one can fail to be struck with the great improvement effected from the central railway station to North-street, and not the least pleasing aspect of the innovation is the great utility of the new pattern of lamp standard, with its ornamental projecting arm, to which the lamp is affixed, the design being that of Mr. May, the borough engineer and surveyor. As the installation progresses, other streets will gradually be electrically lighted."

St. Pancras (London).—The report by the chief clerk on the work of the Electricity and Public Lighting Department during the year ending May, 1895, has been issued. The general increase of business is graphically shown by the following table:

	Increase. From Jan., 1893, to Jan., 1894. Per cent.	Increase. From Jan., 1894, to Jan. 1895. Per cent.
Number of consumers	47	44
Sale of current at 6d. per unit	8	17½
Sale of current at 3d. per unit	94	212
Supply to private houses (exclusive of trade premises, etc)	34	49
Number of lamps connected (in 16 c.p.)	24	22
Highest load point	17	23
Total sale of current (excluding public lighting)	13	33
Money value of current consumed	10¼	26

London County Council.—The Fire Brigade Committee, on Tuesday, recommended to the Council that the seal of the Council be affixed to agreements (in duplicate) with the Post Office in respect of two fire-alarms in Rheidol-terrace, Islington, and Teviot-street, Poplar, and in respect of telephonic communication between the Watling-street station and the firemen's watch-boxes in Mansion House-place, Upper Thames-street, and the General Post Office, Clerkenwell station and the watch-box on Snow-hill, White-cross-street station and the watch-boxes in Love-lane and Bartholomew-close, Bishopsgate station and the watch-boxes in Eastcheap and Finsbury-circus, St. John's Wood station and the watch-box in Kilburn-park-road, Kennington station and the Battersea river station. The Parks and Open Spaces Committee reported that the Post Office authorities had applied for permission to erect a telegraph pole on Nunhead Green to carry a wire to a fire-alarm post. The committee thought it desirable, as far as possible, to avoid the erection of posts and wires on and over the public recreation grounds, and the Fire Brigade Committee, having been informed of their opinion, have decided to have the wire laid underground. The committee therefore recommended that permission be given to the Post Office for the wire across Nunhead Green to be laid underground.

Llandudno.—The Urban District Council have received applications from two quarters for permission to lay down electric tramways in the district. As the Council expect shortly to receive a third application, they deferred their decision until its arrival. They also instructed that it should be ascertained from various electrical engineers their terms for advising and reporting upon the electric lighting of Llandudno. The Electric Lighting Committee resolved that the engineer be instructed to write to the following electrical engineers, forwarding copies of the Llandudno electric lighting provisional order, and asking for their terms for advising and reporting generally upon the whole question of the electric lighting of Llandudno—viz., Mr. F. H. Medhurst, London; Mr. Preece, London; Mr. T. L. Miller, Liverpool: Messrs. Kincaid, Waller, and Manville, London. This having been done, the committee recommended that the terms of Messrs. Kincaid and Co. be accepted for a report, and on the matter coming up in the Urban Council the chairman moved, and Mr. E. Jones seconded, that the report be adopted. Mr. Bellis moved an amendment that the Council invite competitions for the supply of electric light, and then take the advice of an eminent engineer on the schemes submitted. Mr. Marks seconded the amendment, and it was carried. It was subsequently decided that all applications as to tramways should be referred to a committee.

Aberdeen.—The directors of the Aberdeen District Tramways Company have had under consideration the terms on which the company would be prepared to dispose of the tramway system to the Corporation, but no definite conclusion was arrived at. The School Board have remitted the question of introducing the electric light into the Board's offices to the Finance Committee with powers to act, the first cost being estimated at not more than £20. The Gas Committee of the Aberdeen Town Council recently reduced the price of electrical energy, offering to supply a daylight service for electric motors at a reduction of 25 per cent. on the cost for lighting. Already the public are taking advantage of this decision. The workshops at Gordon's College are fitted with two motors, where 6 h.p. is available for driving wood and metal working machinery. Councillor Fleming has also in daily use an electrically-driven crane for lifting and transporting large logs of wood from end to end of his establishment at Albert Sawmills. With a view to encouraging the public to avail themselves of electric motors as labour-saving appliances, the Gas Committee have arranged with Mr. Spark, electrical engineer, Belmont-street, to exhibit a turning-lathe at work in their gas-stove depot. The lathe, which has been made by Mr. Henry Milnes, of Bradford, is of high-class manufacture, all the working parts, including toothed wheels, being cut from solid cast steel, and embodies several ideas which Mr. Spark suggested to the maker.

Worcester.—The City Council have received from the Water and Sewerage Committee an important report, involving the expenditure of upwards of £30,000 for purposes of water supply, including the following work: brick building for electric motors, pump wells, pumps, etc, and bridge from waterworks to the island; estimated cost, £1,703. At the last Council meeting Mr. G. H. Williamson moved that Messrs. J. Ward and Sons should provide and fix a steam-pipe apparatus with McDougall's steam-traps, as mentioned in their estimate, for heating Powick generating station, for £70. 5s. The generating station was, he said, completed towards the end of last autumn, and then no provision was made for heating the large hall in which the engines and turbines were worked. During the long and severe frost the employés had had to use much more coal than was otherwise required, and had also suffered great inconvenience. It was very injurious to the machinery to have great changes of temperature. This motion led to a long discussion upon the cost of the electricity works, and an amendment was moved, "That it be an instruction from the Council to the Electricity Committee that they should supply the Council with a statement of all costs and expenditure incurred from the commencement of the electricity works to the present time, and also a statement showing all income from all sources up to the present time, and the amount of all works entered into by them and not yet carried out." The amendment was, however, rejected, and the original motion was carried.

The South Staffordshire Tramways.—This company is approaching another critical period. Their last license for the use of steam on their lines is fast running out, and the Board of Trade have intimated that they will not renew the license further than December 31 unless the sanction of the local authorities is first obtained. With reference to a new system of traction much has been said about electricity with the overhead wires, but it is stated that there is a consensus of opinion upon its good qualities and cleanliness, only the West Bromwich and Handsworth authorities being opposed to it. The following letter has been received by the Tipton Urban District Council: "Walsall, November 25, 1895. Dear Sir,—South Staffordshire Tramways—We think you should know that there are persons at the present time who are prepared to take over the tramways, discharge the liabilities of the present company, equip with cable that part between Carter's Green and Handsworth, and equip electrically on the overhead system the rest of the line. In view of this, we think any further extension of the steam license is undesirable. It is not to the interest of the debenture-holders (some of whom we represent) any more

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than of the public that the present engines should be perpetuated, and we look upon the money now being spent in repairing them as thrown away. We recognise the inconvenience of the stoppage of the traffic, but the question is whether it is not better to face a temporary stoppage in order to force the adoption of a better system than to allow matters as they are.—Yours faithfully, DUIGNAN AND ELLIOTT.—G. M. Waring, Esq., clerk to the Tipton Urban District Council."

Cardiff.—For some months past Charles-street, Cardiff, has been illuminated by gas lamps with incandescent burners, the departure being introduced with a view of ascertaining if the lighting of side streets at Cardiff could be improved by the system without any increase of expenditure. A local reporter has asked the borough engineer if the new light was a success. Mr. Harpur replied without hesitation in the negative. He added, "The expenditure is precisely the same. The same quantity of gas is being used. I have gone carefully into the matter of the cost, and there has been no economy whatever, notwithstanding the fact that the burners are of the most improved type. I don't think the burners are at all suitable for street-lighting." The Chairman of the Lighting and Electrical Committee has stated that it will be necessary to put down additional plant at the electric light works. The Exhibition Committee would require 101 arc lamps and 539 incandescent lamps, but they also added to that number 25 per cent. for contingencies. This would necessitate about 350 additional horse-power, and as the Corporation would be compelled very shortly to extend their plant to meet the requirements of private consumers, he suggested that an application be made to the Local Government Board for power to make such extensions in time to supply the exhibition. The whole question was referred to a sub-committee to report upon, and the Chairman promised to call a meeting of the General Committee as soon as the report was ready for presentation. Subsequently, Mr. Munn stated that the committee could not take further orders for private lighting until the plant was increased; in fact, they could not comply with the orders they had received.

Royal Electric Company of Montreal.—Messrs. Coates, Son, and Co. have been authorised by the directors of the Royal Electric Company of Montreal to receive subscriptions at 105 for £34,000 4½ per cent. first mortgage debentures, the balance of a total of 750,000dol.—say £154,000—the first portion of which was offered a year ago. The debentures, which rank *pari passu* with those already issued are secured on the immovable property, machinery, and plant, subject only to certain other charges amounting to £5,525, and all maturing for payment by 1897. The debentures are redeemable to the extent of £1,700 per annum, by annual drawings at 105, commencing April 1 next, or by purchase on the London and Montreal Stock Exchanges at a lower price, the company, however, reserving the right to redeem at 110 at any time, on six months' notice, the whole of the debentures then outstanding. The Company was formed in 1884, and has a capital of 1,500,000dol., of which 1 000,000dol. is paid up, and there is also a reserve fund of 308,000dol. The prospectus states that regular quarterly dividends at the rate of 8 per cent. have been for some time past distributed on the paid-up capital; and that the net revenue from the contract with the Montreal Corporation is alone more than sufficient to provide for the interest on the debentures, while apart altogether from such contract, the net income from incandescent lighting, commercial arc lighting, the supplying of motor power, and the manufacturing department, is more than is required for both interest and redemption charges. The value of the assets at the end of the last financial year, according to the certified statement of accounts, amounted to 2,226,000dol. The subscription list closed last Monday.

Sheffield.—With reference to the scheme of electrical tramways mentioned last week, a reporter of the Sheffield *Telegraph* has interviewed Mr. W. Page, the representative of the London and Provincial Tramway Company Syndicate. Mr. Page was very busy looking after the lithographing of the plans—all the preliminary work is being done in Sheffield. He said: "our system will be substantially the overhead electrical system, and when the time comes for equipping the lines we shall include all the latest and best improvements in our scheme, though the system is already as nearly perfect as we expect to see it. To illustrate," he added, "the readiness with which overhead electrical traction is adopted, I may mention that at Milan there are poles and wires under the very shadow of the cathedral—one of the grandest piles in the world; and at Genoa the poles and wires run down a street—not a very wide street, either—lined with ancient palaces, built of marble." Mr. Thos. Crookes, of the Atlantic Works, Sheffield, writes: "I venture to ask if some of the various heads and falls on the Rivelin which belong to our Corporation could not be be utilised for producing the necessary motive power for working the tramways by electricity or by cable, or the two combined, instead of erecting large steam-engines for that purpose. The Corporation own on the Rivelin 17 mills, or, rather, heads and falls (as some of the mills have gone, and others are going to rack and ruin), the net annual income of which is only between £500 and £600. The total head and fall from the top mill down to and including Walkley Tilt, is about 260ft., which probably is equal 400 h.p. at the least, and would propel cars by electricity on tramways three or four times the length of the present system."

Tottenham (Middlesex).—The General Purposes Committee of the Tottenham District Council having preliminarily considered the subject of the electric lighting of the parish, have found—as far as they were able to ascertain—that unless accompanied by a large demand from private users the cost of public lighting by electricity would be largely increased over that of gas; further, that the question of the introduction of an installation of electric light for the district was essentially one for consideration by an electrical expert, and if the Council decided to proceed they thought that such an expert should be engaged to consider the question and report to the Council. With the view of having full information on the question of improving the public lighting of the district, the committee recommended that arrangements should be made for a trial of the incandescent gas light in certain parts. Mr. Malone moved that the Council should appoint an engineer. He understood that Mr. Medhurst, an electrical engineer appointed at Fulham, had reported that when parishes had enough dust and refuse the burning of it enabled them to light the streets for nothing, and to make a profit for the relief of the rates by supplying the light to private consumers. The report and recommendations of the committee were agreed to, and notice was given to move that the Council invite electrical engineers to submit schemes, designs, reports, and estimates; annual cost of working the system; advantages and disadvantages which would arise on profit and loss as compared with the present system of lighting, and whether it would be advantageous to establish the electric light in conjunction with a dust destructor; and that premiums of £50, £30, and £15 be offered for the first three schemes selected.

Folkestone.—A special meeting of the Folkestone Town Council has considered the electric lighting question. The notices on the agenda paper were as under: "(1) To consider the expediency of applying to the Board of Trade for a provisional order to be granted to the Corporation and Urban District Council of Folkestone to light the whole or any part of their district with the electric light, and as to site of generating station, plans, estimates, and details to be prepared and steps to be taken. In the event of the Corporation not passing such resolution to apply for a provisional order. (2) To consider an application on the part of Mr. Daniel Baker for the Corporation to assent to and support an application for a provisional order, in the above form, on the part of himself or his nominees. To consider from the Capital and Counties Electricity Supply Company, Limited, of their intention to apply on or before December 21 next to the Board of Trade for a provisional order to authorise the company to supply electricity for public and private purposes within the borough of Folkestone." The town clerk read a letter which he had received from Messrs. W. G. F. Webster and Co., in which reference was made to the offer of Mr. Webster to light the Leas at a certain specified cost, and stating that if the Corporation decided to go on with the matter, they would undertake to get the installation completed next year. Councillor Baker proposed a formal resolution prepared by the town clerk. He remarked that they were face to face with an alternative. They must either get a provisional order to light Folkestone themselves or they must allow someone else to do it. In his opinion they should do it themselves. They saw there were two other notices on the paper—one from himself and another from another company, and they heard there was another application from Mr. Webster. No doubt they would get any number of others who would be only too pleased to step into the gap. If they got a provisional order and thought fit to sell it they could make £500 or £1,000 out of it. It was imperative that they should have electric light at the west end of the town, and unless the Corporation were prepared to supply it he must do it himself. The motion was carried unanimously.

Swansea.—A report by a sub-committee of the Swansea Corporation on tramway purchase, after stating that it is incumbent on the Corporation to obtain entire control of the public roads, proceeds as follows: "Another very important factor which has occupied the attention of your sub-committee is the question of running tramcars by electricity. This is desirable, as the heavy gradients in many parts of the road are a great strain on the horses employed, and if this can be arranged, the success of the scheme for the electric lighting of the borough, which has recently been adopted by the Town Council, will be fully assured. The provision of a day load by keeping the machinery employed at a time when there is no demand for lighting would effect a very material reduction in the cost of electricity all round. The working of the cars by electric traction would at once form such a day load Your sub-committee are of the opinion that sufficient electricity for such a scheme can be provided at a cost which would reduce to almost one-half the amount of the cost of electric lighting anticipated by the report to your Electric Lighting Committee, and if these results are attained electric lighting might be provided within the borough at a cost below that now charged for gas by the Swansea Gaslight Company. There would also be a great saving of cost in the wear and tear of the roads. The following terms have been provisionally arranged with the tramway company: (1) The Corporation to purchase the tramlines, depots, and all other rights and property of the tramway company within the borough (exclusive of rolling-stock) for the sum of £32 000. This amount is made up as follows—namely, £10,400 to enable the company to discharge their existing mortgage debt the balance to be expended by the company in the purchase of motor cars for working the tramway system. (2) The Corporation to double the lines as far as possible, so as to admit of a sufficiently rapid service, and to put in the necessary posts, wires, and bonds, so as to make the line suitable for electric traction. (3) The tramways to be leased to the company for a term of 21 years. (4) The annual rent to be (*a*) the interest annually paid by the Corporation on the total money borrowed with ½ per cent. in addition; (*b*) a sinking fund on tramway expenditure, for reconstruction and additions at 3 per cent. and 21 years; (*c*) a sinking fund on the balance, being purchase-money for tramways, roadways, costs, etc., at 5 per cent. and 30 years. (5) The Corporation to supply electrical power, at a price to be

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agreed upon. (6) The lines to be kept in repair by the Corporation at cost price, but no charge to be made for renewals, which are represented by sinking fund."

PROVISIONAL PATENTS, 1895.

NOVEMBER 18.

21893. **Improvements in electric light fittings.** Nelson Dadge, 8, Great Portland-street, London.

21920. **Improvements relating to the electro-deposition of zinc and other metals upon iron and steel tubes.** James Greenwood, 4, South-street, Finsbury, London.

21924. **Improvements in or relating to wattmeters.** Georg Hummel, 323, High Holborn, London. (Complete specification.)

NOVEMBER 19.

21941. **Improvements in casings employed for electrical wires.** John Dugdill, jun., 17, St. Ann's-square, Manchester.

21993. **Improvements in combined motive power and electric generating and storing apparatus for the propulsion of movable conveyances and analogous power purposes.** George Arthur Washburn, 18, Buckingham-street, Strand, London. (Complete specification.)

21998. **Process for heating rivets electrically.** Gordon Paton Clark, 10, Lansdowne-road, Holland Park, London.

22004. **Improvements in and relating to electrical conduits.** James Fulton Cummings and William Clyman Yawkey, 45, Southampton-buildings, Chancery-lane, London. (Complete specification)

22006. **Improvements in and relating to electric railway signals.** John McCleod Murphy and Albert Francis Pierce, 77, Chancery-lane, London. (Complete specification.)

22023. **An improved thermodynamic process and apparatus.** Philip Arthur Newton, 6 Bream's-buildings, Chancery-lane, London. (Agnes Bates Wellington, United States.) (Complete specification.)

22028. **Improvements in protective coverings for the joints of electric cables.** George Gatton Melhuish Hardingham, 191, Fleet street, London. (The firm of Felten and Guilleaume, Germany.)

NOVEMBER 20.

22060. **Improvements in automatic telephone exchange system.** William Frederick Lounsbury, 57, Barton-arcade, Manchester.

22066. **Improvements in two-way switches.** Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster. (Complete specification.)

22074. **An improved means or method of driving or propelling electric tramcars.** Joseph Morton, Commercial-street, Halifax.

22112. **Improvements in the gearing and arrangement in an electric crane.** Douglas Potter, 68, Victoria-street, Westminster.

22120 **Improvements in electric accumulators or storage batteries.** Thomas William Allan, Arthur Powell, and Charles John Tibbits, 65, Chancery-lane, London. (Complete specification.)

22131. **A new or improved combined brake and dynamometer for loading and indicating the horse-power of the work transmitted through revolving shafting.** William White and Jacques Rodolphe Forrer (commonly called Rodolphe Forrer), 323, High Holborn, London.

22133. **Improvements in telephone message counters.** Friedrich Wilhelm Heinrich Hempel, Max Gumpel, and Alfred Maerker, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

22142. **An improved electric battery.** Paul Falle, 40, Chancery-lane, London.

NOVEMBER 21.

22150. **Improvements in electric indicators for bells, telephones, alarms, and the like.** Stanley Walton, 59, Inverine-road, Old Charlton, London.

22207. **Improvements in electrodes suitable for electrolytic apparatus.** Carl Kellner, 46, Lincoln's-inn-fields, London.

22233. **Improvements in accumulators and their electrode plates, partly applicable to primary batteries.** Moricz Engl and Floris Wüste, 28, Southampton-buildings, Chancery-lane, London.

22234. **Improved means for protecting electrical and magnetic apparatus against the disturbing effects of electric railways passing in proximity thereto.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

22246. **Improvements in and relating to insulators and insulating conduits or tubing for electrical purposes.** Frederick Gwilym Treharne, 45, Southampton-buildings, Chancery-lane, London.

22252. **Improvements in direct electric current transformers or motor-generators.** Alexander Bewicke Blackburn and Thomas Large Boyden, 47, Lincoln's-inn-fields, London.

NOVEMBER 22.

22337. **Improvements in incandescent electrical lamps.** The Edison and Swan United Electric Light Company, Limited, and Alfred William Hill, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

22346. **Improvements in stopcock locks and in electrical appliances used in connection therewith.** Charles Heyman, 53, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, April 23, 1895, being date of application in United States.)

NOVEMBER 23.

22369. **An improved electric arc lamp for magic lanterns.** Herbert Charles Newton, 3, Fleet-street, London.

22408. **Improvements in dry voltaic batteries.** William Durant and Thomas William Baron Durant, The Arcade, Barnsley.

SPECIFICATIONS PUBLISHED.

1885.

4506. **Telegraphs.** Langdon-Davies. (Second edition.)

1892.

17091. **Supporting electric wires, etc.** Crompton and Dowsing (Second edition.)

1894.

22157. **Electrical switches.** McGeoch.

22883. **Electrical measuring instruments.** Binswanger and Stanley.

23279. **Electrically-propelled carriages.** King.

24076. **Telegraphic apparatus.** Hoffmann.

24353. **Electrical conductors, etc.** Siemens Bros. and Co., Limited and Perry.

24906. **Electric current transformers.** Blackburn and Buchanan.

25344 **Electric circuits.** Johnson and Steele.

1895.

42. **Telephonic apparatus.** Binswanger.

226. **Electric call and alarm apparatus.** Herz and Hartfuss.

281. **Telephones.** Oppenheimer.

14858. **Electric meters.** Harris.

15686. **Electric railways.** Thompson. (McLaughlin.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6¼
Brush Company, Ordinary	3	1⅞-1⅞
—— Non. Cum., 6 per cent. Pref.	2	1⅞-2⅛
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5⅛-5⅜
Chatham and Rochester	—	-
Chelsea Electricity Company	5	6¾-7¼
—— 4½ per cent. Debentures	100	115-118
City of London, Ordinary	10	18-18½
—— 6 per cent. Cumulative Pref.	10	15½-16½
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	130-132
—— 5 per cent. Pref. Shares	10	14⅜-15½
County of London and Brush Provincial Co., Ordinary	10	8¼-9⅛
—— 6 per cent. Cum. Pref.	6	8½-9
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1⅜-2⅛
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅝-¾
—— 7 per cent. Cumulative Pref.	2	2-2⅛
Elmore's Copper Depositing	2	⅜-½
Elmore's Wire Company	2	⅞-1
Fowler-Waring Cables	5	1-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	14-14½
—— 7 per cent. Preference	10	15½-16½
—— 4½ per cent. Debentures	100	108-111
House-to-House Company, Ordinary	5	4½-4⅝
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	18-19
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge Ordinary	5	7⅜-8⅛
—— 6 per cent. Pref.	5	7-7⅛
Liverpool Electric Supply, Ordinary	5	7⅜-8⅛
Liverpool Overhead Railway	10	10½-11
—— 5 per cent. Pref.	10	15½-15¾
—— 4 per cent. Mortgage Debentures of £100	100	113-115
London Electric Supply	5	8-8¼
Metropolitan Electric Supply	10	10¾-11¼
—— 4½ per cent. First Mortgage Debenture Stock	100	117-120
National Telephone, Ordinary	5	5⅞-6⅛
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15½-16½
—— 5 per cent. Non. Cum. Third Pref.	5	6⅛-6⅜
—— 3½ per cent. Deb. Stock	100	105-107
Notting Hill Company	10	8½-9
Oriental, Limited, £1 shares	1	1-1⅛
—— £5 Shares	5	7⅛-8
—— £4½ shares	4½	6¼-6¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-105
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8-8½
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	39-41
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4⅛-5
Westminster Electric Supply, Ordinary	5	8-8½
Yorkshire House-to-House	5	6¼-7¼

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NOTES.

Obituary.—We regret to learn of the death of Mr. John Muirhead, some time principal of the late firm of electrical engineers, of Westminster, who have erected telegraphs and carried out other electrical works in many parts of the world.

Electrical Engineering at the Cape.—An Electric Lighting and Power Act has recently been passed at the Cape of Good Hope, authorising regulations for the safety of the public. We understand that Mr. A. P. Trotter has been appointed Government electrician and inspector under this Act.

Popular Electrical Lectures in Austria.—With the view of popularising the knowledge of electricity, the Vienna Elektrotechnischer Verein has arranged for the delivery of a series of 10 easily-comprehended lectures on electrical subjects. Subscriptions for the whole course range from 6fl. to 15fl.

Power Transmission in Holland.—The repairing shops of the Dutch State Railways in Utrecht derive their motive power and are electrically illuminated from the electric light station, situated about a mile away. A full description of the installation appeared in a recent number of the *Tydschrift* of the Dutch Royal Institution of Engineers.

The Proposed School of Engineering in Sydney. The *Times* states that Mr. P. N. Russell, founder of an engineering firm in Sydney, who recently proposed to give the sum of £50,000 for the endowment of a school of engineering in the University of Sydney, has received a telegram from Sir William Windeyer, chancellor of the university, gratefully accepting his munificent offer.

Genoese Electrical Trams Interdicted.—It is stated that the police of Genoa have prohibited further operation of the electric trams on account of recent numerous accidents, which it appears are mainly caused by the heavy gradients in the city. Coming down the inclines the brake power has either failed or has not been promptly or efficiently applied, and the cars have derailed and caused considerable mischief.

Magnetic Observations on Hardened Steels have led Mr. J. O. Arnold, in his paper on "The Influence of Carbon on Iron," read on Tuesday, December 3, at the Institution of Civil Engineers, to the conclusion that (1) the magnetic permeability varied inversely as the carbon present; (2) the permanent magnetism was directly proportional to the carbides of iron present; and (3) in iron containing between 0·1 per cent. and 0·9 per cent. of carbon the permanent magnetism was directly proportional to the sub-carbide of iron present.

The Revised Electric Lighting Regulations.—Lord Kelvin, Mr. W. H. Preece, and Major Cardew, the committee of experts appointed by the Board of Trade, have, it is understood, presented their report on the questions which were referred to them as a result of the recent conference on the proposed new electric lighting regulations, presided over by Sir Courtenay Boyle, the permanent secretary of the Department. The principal matter on which the committee were asked to advise was as to the definition which should be officially laid down to constitute "low pressure." The tenor of the report is not at present known.

A Warning.—The man who, pretending plumbing purposes, used to gain access to houses with nefarious intent, has apparently given way to a more enlightened individual. Work, as our readers know, was recently commenced on the electric lighting installation at the Cancer Hospital, Fulham. Some quick-witted thief has utilised this information to effect a plausible entry into the building and appropriate watches, jewellery, and money. The secretary of the hospital states that by the careful measurements which the man took, and the marks which he put on the walls to show where the switches were to be, he effectually gulled the officials.

The Volatilisation of Carbon.—M. Moissan finds that when carbon is volatilised in his electric furnace it evaporates without melting, and that when the vapour condenses it always deposits as graphite. He also finds that aluminium carbide may be made, mixed with metallic aluminium, by the direct reduction of alumina with carbon in the electric furnace, and that when this carbide is treated with water it evolves chiefly marsh gas or methane (CH_4), not acetylene. This promises to furnish a new starting point for the methyl compounds and derivatives, which have hitherto been derived from the products of distillation of wood; and it casts some light upon the cause or origin of natural gas.

The Dangers of Paraffin Lamps.—The Home Secretary has written as follows to a correspondent who called his attention to the fact that during the six months ending last September there were, in London, 211 lamp accidents, 23 of which proved fatal, and asked whether the sale of cheap lamps could not be prevented by legislation: "Home Office, Whitehall, December 2. Sir,—In reply to your letter of the 26th ult., on the subject of the frequency of serious accidents from lamp explosions, I am desired by the Secretary of State to say that he hopes to be able when Parliament reassembles to secure the reappointment of the Select Committee which has sat in previous years with a view to legislation on the matter in question.—I am, yours very truly, W. P. Byrne."

An Electrically-Lighted Hindu Temple.—The *Times of Ceylon* learns that it is in contemplation to introduce the electric light into the Sivan Hindu temple at Kochicadde, on the main road to Mutwal, Ceylon. The premises of the Hindu place of worship are at present lighted by gas, and the trustees propose to substitute the electric light for gas; but whether they will introduce it into the interior of the building is a matter which is now under their consideration. It is said that if the Sivan Hindu temple introduce the innovation the trustees of the equally wealthy temple of the Natukotta in Sea-street "are sure to follow the example set by their more enlightened brethren." There is no question, we think, that the coming "Light of Asia" is the electric light. The temple event is one that Siva, when Brahma and Vishnu were absent, would probably have termed Parbutta—auspicious.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on the 2nd inst., Sir James Crichton-Browne presiding, when the following were elected members: Messrs. C. H. Berners, J.P., J. M. Bruce, M.D., F. Chambers, A. M. Chance, J.P., A. E. Fletcher, F. Fox, J.P., H. Seymour, K. T. Stewart, M.D., G. H. Strutt, F. Tendron, F.G.S., W. H. Warner, M. Webb, J.P., and Mrs. S. H. Phillips. The Right Hon. Lord Rayleigh, professor of natural philosophy, R.I., is to deliver six lectures on light. The Friday evening meetings will begin on January 17, when a discourse will be given by the Right Hon. Lord Rayleigh on "More about Argon"; succeeding discourses will probably be given by Prof. Burdon Sanderson, Mr. W. S. Lilly, Dr. John Murray, Mr. J. J. Armistead, Dr. Edward Frankland, Mr. A. R. Binnie,

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Mr. Sydney Lee, Prof. T. R. Fraser, Prof. Dewar, and other gentlemen.

Electricity in Manufacturing Processes.—The second lecture in the series arranged by the Technical Instruction Committee of the Haslingden Corporation, in connection with the Victoria University, was recently delivered by Mr. F. G. Baily, lecturer on electrotechnics at University College, Liverpool, who illustrated his remarks by electrical apparatus specially requisitioned for the occasion, the Corporation steam-roller being pressed into service for the purpose of driving a dynamo. The address was an interesting one, and was well received. We wonder if Mr. Baily has seen the report thereof which appeared in the *Accrington Observer* of November 30? If he has not, he should see it. It is, like Frankenstein's galvanised monster, fearfully and wonderfully made. In it we have tripped across such delightful little pleasantries as "amphieres," "carbide of syllicum," "clorine," and "phosphorous"; while "armyised plates" occurs three times. We expected better things from Accrington.

Compensating Device Against the Effect of Electric Railways.—At the last meeting of the Elektrotechnischer Verein in Berlin Dr. O. Frölich read a paper on, and gave demonstrations with, a "Compensating Device for Measuring Instruments." He proposed, for compensating purposes, that a number—say seven—of thin wires be connected with the point of the rails nearest to the instruments and led to box-shaped frames which would be placed over each instrument. All frames, with their various windings, the wires of which were to be insulated from each other, would be connected in series. In the various leads small regulating resistances would be inserted in order to vary the pressure of the current at will. Dr. Frölich said that the experiments in Dresden and Pankow-Berlin with his device had given very satisfactory results, but the arrangement was unfavourably criticised by Dr. Kohlrausch. At the same meeting Herr Geh. Postrath Münch gave a "Communication on Induction Phenomena in Telegraph and Telephone Wires." He disputed the theory of the former telegraphic engineer, Herr Müller, that the disturbances on telephone lines were attributable to the passing over of currents. The discussion hereon was postponed.

The French Submarine Boat "Goubet."—*L'Energie Electrique* of December 1 contains a long article, signed 'E. L.," on an improved form of the French submarine boat "Goubet." The article is illustrated with outside views of the old form and the improved form of the "Goubet," but no drawings are given of the details of the interior. The boat is cigar-shaped, or rather fusiform, with bilge keels or flanges. It is 26ft. long by about 12ft. across, and is made of gunmetal. There is no deck, access being obtained by a manhole closed by a gunmetal dome about a foot high. The cross-section is circular, and the construction is calculated to support the water pressure of a depth of 160 fathoms. The weight is 10 tons, and the boat is manned by a crew of one officer and two sailors. Air for respiration is stored under pressure in steel cylinders, and pumps are provided to get rid of the used-up air. Normally, the "Goubet" floats with the manhole above the surface, but when it is desired to sink, the water is admitted to chambers provided for that purpose and pumped out again as required. The boat is driven by a screw, the motive power being obtained from a battery of 56 cells, weighing altogether about a ton, and giving a 20-ampere current at 90 volts for 14 hours. A Paterson and Cooper motor is used, geared down to drive the screw at 250 revolutions. The steering is done by altering the direction of the screw, which is fixed on a special joint, and there are also paddles worked by hand in case of breakdown. A curious feature is a long telescope-jointed tube, to be thrust to the surface for purposes of observation, and last, but not least, a weight is carried which in case of accident or difficulty occurring can be detached, and the boat then rises immediately to the surface. The "Goubet" has been tried on the Seine, and is to be further experimented with at Cherbourg. The French Government have not adopted the boat, but the present one is stated to have been sold to a foreign Power.

Mechanical Road Carriages.—The first of three Cantor lectures by Mr. W. Worby Beaumont, M.I.C.E., on "Mechanical Road Carriages" has been delivered at the Society of Arts. After commenting on the importance of the problem of easy transport to a country, he briefly traced the history of the attempts to produce practical road carriages, remarking that those who were working at the subject now might learn much from the failures of their predecessors. The first carriage that was at all successful was made in 1769, and was followed at a few years' interval by the inventions of Murdock, Symington, and Trevethick. For about a quarter of a century after the latter not much of note was done towards the construction of a practical carriage. Several of the inventors who took up the problem seemed to have disbelieved in the adhesive power of wheels, and therefore patented machines with legs meant to resemble those of a horse. Lack of sufficient boiler power was a frequent cause of failure. In 1831 a service of steam-coaches was established by Gurney between Cheltenham and Gloucester, but they were soon forced off the road by the action of the turnpike authorities. Hancock was the really successful man of early nineteenth-century work. He made a number of carriages of different forms, which ran successfully on the roads till driven off by the opposition of public and private interests. It was evident that 60 years ago a very remarkable degree of success had been attained, for it had become possible to build steam-coaches that could run from London to Birmingham and from Birmingham to Cheltenham. But still it could not be concluded that the failure of such carriages to establish themselves permanently was due solely to the opposition they encountered, and it was other than mere mechanical conditions that made it impossible to conduct traffic with them on better terms than could be done with horses. Mechanical means must in a sense be considered as secondary to the comfort of the passengers carried, for the public would not care a jot for the perfection of the motor if they had not comfort in the vehicle. Success, Mr. Beaumont said, would be obtained by the co-operation of the carriage builder and the engineer—not by the work of the latter alone.

Electric Power in Coal Mines.—Is the present position of power distribution by electricity such that we may use it with confidence for the whole of the power required at a colliery? To this query Mr. L. B. Atkinson, in *Cassier's Magazine* for December, replies "yes." The largest engine at a colliery is the winding engine, and suppose this, he says, to require to be capable of developing power at full speed of 1,000 h.p., which is an outside figure. This could be well replaced by two motors of 500 h.p., one on each end of the shaft of the drum, without gearing. There are numerous cases of dynamos and motors of this power working with ease and satisfaction and giving no difficulty whatever, and operated by ordinary mechanics with no more trouble than an ordinary steam-engine. Motors of smaller sizes are in use all over the world with universal satisfaction. Are the claims made for efficiency of electric distribution of power realised? he

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asks. On this point the author has examined, carefully, tests made by himself and by others on electric power plants, and has arrived at this conclusion: While the efficiency of distributing electric power and its utilisation in the motors does come up to that claim, the efficiency of the production of electricity is not as a rule as high as is claimed, or as high as may be realised, and the reason is that sufficient account is not taken of the fact that the average load is considerably less than the maximum requirement. In one known case, where the efficiency of electric generation—that is, the proportion between the electric power delivered to the cables and the indicated horse-power of the engine—is as high as 86 per cent. at full load, it falls to 74 per cent. at half load, and to about 58 per cent. at one-quarter load. The reason for this is to be found in the power the engine takes to drive itself. The engine is generally arranged to work with an economical cut-off at the full load or maximum power, and consequently is larger than necessary for all smaller loads. It should be arranged to work with an economical cut-off at the average power. The moral, Mr. Atkinson concludes, is to use engines with automatic expansion valves, permitting the engine to work with a cut-off as late as half or five-eighths of the total cylinder volume when developing the maximum power, and working with a more economical grade of expansion at the average load.

Electric Lifts.—M. E. Hospitalier, writing on this subject in *L'Industrie Electrique* of November 25, says that the price of water for hydraulic purposes having been raised in Paris from 32 to 60 centimes (5½d.) per cubic metre has caused attention to be given to the question whether a motive power for lifts could not be adopted which would prove cheaper than water at the low pressure at which it is supplied by the waterworks company. Electric energy is now available in all the more important streets of Paris, and many designs of electric lifts having been invented and worked out by the manufacturers, their use is beginning to spread rapidly, so that, M. Hospitalier thinks, soon no house of any importance will be built without an electric or hydro-electric lift. With reference to price, it is remarked that while a cubic metre of water and a kilowatt-hour cost in Paris under the present condition of things exactly the same price—namely, 60 centimes—the water is supplied only at a pressure equal to a head of 30 or 40 metres, equivalent to 40,000 kilogram-metres per cubic metre used, while the kilowatt-hour represents 360,000 kilogram-metres, or 10 to 12 times as much as the water. With so large a margin available it is not surprising that electricity has been used for operating cable lifts worked directly from electric windlasses—a system adopted only in America—and also for supplying by some appropriate mechanism the water pressure necessary to work lifts on the hydraulic system. Electrically-worked chain lifts are counted by the hundred in the large American towns, where some of the "sky-scraper" buildings of 12 to 18 floors may have as many as 10 each, all at work during business hours. These carry 12 to 15 persons at once at a speed as great as three metres (say 10ft.) a second, and working during the daytime furnish a convenient output for the energy of the central station. They are not, however, used in Paris because there the public, accustomed to hydraulic piston lifts, do not think them safe. Moreover, besides this purely imaginary reason, the question of cost comes in to prevent their adoption. Putting in a new electric lift or converting a hydraulic lift into a chain lift costs about 10,000fr. (£400), while the additions necessary to a hydraulic lift to obtain the water pressure from electrically-worked apparatus cost less than 4,000fr. (£160). In some systems the conversion can be made without altering any of the existing apparatus, and the lift can be worked at choice either electrically or by using the town water supply. This gives a security against interruption of work which ought not to be neglected, and hydro-electric lifts of this pattern are consequently to be preferred.

The Durability of Porcelain as an Insulator.—Mr. James Pass, writing in the *Electrical Engineer* (New York) of November 20, says that it can hardly be questioned that porcelain, when skilfully compounded and carefully made, is an excellent and durable insulator. The recorded experience with this material for aerial lines in England, where it is used in preference to all other materials, should have some weight. It seems also to be well established, so far as laboratory tests can establish such claims, that porcelain, when well made, is a better insulator than glass, especially for high voltages. But how are we to know that the insulator which looks well and lasts well to-day will still be a good insulator five years hence Laboratory tests do not enlighten us on this point, and appearance is no indication whatever. Of course, certain gross faults may easily be detected—such as an imperfect vitrifaction, etc. But to make a porcelain body which is perfectly vitrified and yet has considerable strength to resist fracture requires experience and technical skill; and to make such a porcelain and cover it with a perfect glaze that will not crack in time, has from the dawn of the pottery industry taxed to the utmost the skill and ingenuity of the practical potter. This cracking of the glaze is called among potters "crazing," and is generally known by that name; perhaps from the fact that its unwelcome and unexpected appearance has driven so many good men to the brink, if not into the slough, of mental despair. The glaze used on porcelain is peculiar, and there is little resemblance between the formulæ for this glaze and those for ordinary glass. A porcelain glaze must attach itself very firmly to the body when heated to near the melting point of that body, and it should have as nearly as possible the same coefficient of expansion as the body which it covers. The exact adjustment of glaze to body is difficult to attain, the glazes having usually a larger coefficient of expansion than the bodies. "Crazed" porcelain should never be used as an insulator, for when subject to moisture the fissures in the glaze fill with water by capillary action, forming excellent channels for leakage of current. It should be a source of regret that such large quantities of defective porcelain have been used in the construction of electrical devices. Mr. Pass knows of reputable manufacturers of electrical apparatus who have assembled and sent out in the market to do service in permanent installation tons of this defective porcelain; and he has again seen some of the same articles that had evidently done service in a damp place and every crack in the glaze was filled with verdigris. Good porcelain can be had, and at reasonable prices as compared with the cost of porcelain for other purposes, but poor porcelain that is "crazed," or is liable to craze, or is imperfectly vitrified, will be used because it is cheap and "passes inspection." It should be required that all porcelain bear the manufacturer's name, and a rigid inspection should prevent the use of "crazed" porcelain in new work, or its continued use in old work. This, Mr. Pass thinks, would in a short time give us a better insulating material, and one that could be depended upon.

The Light Railways Conference, which was held last Thursday at the Westminster Palace Hotel, enjoyed a good attendance, amongst those present being Sir A. Rollit (chairman), Sir David Salomons, Major Rasch, M.P., and representatives of various county councils, local authorities, and public bodies, including the Institution of Elec-

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trical Engineers, Tramway Institute of Great Britain and Ireland, and the Surveyors' Institution. The Chairman, in opening the proceedings, said that latterly great interest had been taken in light railways, but it was to be regretted that the interest had chiefly manifested itself in the work abroad. The instances of light railways in this country were few and exceptional, probably owing to the faulty character of the Acts of Parliament under which they had to be constructed. Some of those Acts had remained dead letters, and the costly procedure and practice attending them had been such as to prevent the progress of the enterprise in Great Britain. The present conference had been called together in the hope that they might be able to advance legislation, and with that object the meeting would be asked to discuss the general principles of the question of light railways and the leading principles and provisions of Mr. Bryce's Bill. The only country where so far the State had not co-operated in the making of light railways was Holland; but the lesson to be drawn generally from the experience of other countries was that they should ask the State to do something. Belgium, France, Hungary, and Italy had their light railway systems supported by various authorities under various conditions, and we in this country would have to be guided by local circumstances. Major Rasch, M.P., moved: "That this conference heartily approves the establishing of light railways under an improved system of procedure and regulations, and with State and local aid to private enterprise; and urges her Majesty's Government to introduce proposals for legislation on the subject at the earliest possible opportunity during the ensuing session of Parliament." Mr. Carruthers Wain, president of the Tramways Institute, seconded the motion. He urged that it was a waste of time to discuss Mr. Bryce's Bill, for it was merely the outcome of the laborious series of platitudes compiled by the majority of the Light Railways Committee. It was impossible to base any legislation on their suggestions. Mr. Elliot Cooper related his experience in the construction of 50 miles of light railway from Cremona to Piacenza, in Italy, showing that the road was taken advantage of in some portions of its length. The great defect of the Bill of last session was, he said, that it did not lay down anything approaching to hard-and-fast lines in order to guide the Board of Trade as to what it was they had to sanction. The regulations of the Board of Trade should be entirely altered. An amendment proposed was lost, and the original resolution was carried unanimously. Mr. Vaughan Davies, M.P., then moved: "That those present form themselves into an association, with power to add to their number, to promote the object of the previous resolution, and that Mr. J. Wallis Davies be appointed secretary," and this motion was eventually adopted.

Anglo-Foreign Technical Dictionaries — good ones, that is to say—are not very plentiful even in these days of advanced science; but especially, and perhaps necessarily, are those scarce which relate to the domain of electricity. The ever-useful "Karmarsch," it is true, has not dallied in the progress of its editions in the insertion of electrical terms, but then it is always a general dictionary, covering a wide field, and therefore expensive. We have before us the very latest effort to supply a much-felt want in the shape of an "Elektrotechnisches Wörterbuch, Englisch-Französisch-Deutsch," by the late Herr J. Sack, director of telegraphs, edited and supplemented by Herr Arthur Wilke, and published by Herr Oskar Leiner in Leipzig at the price of 4½ marks, or 4s. 6d. It is a creditable but somewhat irregular compilation, based in the main on Sloane's "Standard Electrical Dictionary," Houston's "Dictionary of Electrical Words, Terms, and Phrases," and Lefèvre's "Dictionnaire d'Electricité." We say "irregular," because, instead of each of the three divisions being complete in the three languages, the first section is English-German only, and the second French-German only, the third being perfect—German-English-French. This is a failing, however, which will more affect the British reader than the German term-hunter, for whom the volume is primarily intended. Herr Wilke cautiously estimates the yearly increase of electrical expressions in each language at "several dozen," and he mildly complains of the readiness with which the British, and especially the American, electrical engineer coins words in his profession. The editor is too much of a purist to insert the colloquial American "booster"—"Zusatzdynamo"—"supplementary dynamo"; but he thinks, in his preface, that the erstwhile slang word may become part and parcel of the Queen's English in good time. Of "dashpot" he gives the German equivalent in the dictionary as "Stossbremse," but he remarks that the English word is used by both German and French, just as we sometimes use the German "Drehstrom," without translating it into "rotary current." As to "trolley," again — German "Kontaktrolle" or "Laufrolle," French "poulie de contact"—Herr Wilke notes that in France it has recently become "trôlet," and he recommends "Trolle" to Germans, these two terms, it will be seen, practically preserving the pronunciation of our "trolley." It is, of course, always easy to pick holes in a work of this kind, but we cannot help noticing one or two inconsistencies. Why on earth, for example, in translating "air-gap," and "entrefer," its French equation, into German is the usual direct equivalent "Luftzwischenraum" not given instead of the encyclopædic "Zwischenraum zwischen der Feldmagnetpolfläche und dem Ankereisen einer Dynamo"—literally "space between the field-magnet pole surface and the armature core of a dynamo"? The consultation of ancient dictionaries is, moreover, evidenced by the spelling "oxyde." We do not, further, like the "swingings" of a magnetic needle, nor the "pik-up circuit," nor "rotatory currents," nor "redresser" (rectifier) given as the sole equivalent of "Gleichrichter"; nor "annunciator" for "indicator," nor the ambiguous treatment of the foreign representation of "cut-out" and "switch"; albeit, the new Leipzig work is, on the whole, a valuable one.

Edison on Patents.—Mr. Edison has recently communicated to a diligent interviewer some particulars as to the profits which he is alleged to have derived from his devices. "Considered purely as inventions," he is reported to have said, "they have cost me more than I have ever received from them. At least nine of my inventions have proved very profitable. These are the district telegraph system, the quadruplex system of telegraphy, the stock ticker, the telephone, the electric pen and mimeograph, the incandescent lighting system, the electric railroad, the phonograph, and the kinetograph. I claim one-half of the credit for the invention of the first, the third, and fourth of these, and the others are entirely my own work. I received very little for the district telegraph. I sold the quadruplex system of telegraphy for 30,000dol., and spent all of this sum, and more, trying to devise a plan to make a wire carry six messages instead of four. I failed, and so in the end was worse off than when I began. The stock ticker brought me at different times about 50,000dol., but it cost me more than that to perfect it. From the telephone I realised a clear profit of perhaps 25,000dol. Bell made less than half a million, though his father-in-law rolled up a vast fortune by securing control of large blocks of stock when it was selling for little or nothing. The profits of my electric pen

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and mimeograph have been very small. The incandescent light has netted me 140,000dol.; it cost me nearly three times that sum to perfect it. I did not get my money back from the electric railway, which I sold out long ago, and I made nothing from the phonograph, which I have also sold. The kinetograph has not as yet returned me the original outlay. Our present patent laws, which, as interpreted by the courts, encourage perjury and put a premium on fraud, are worse than a farce, and I would have been a gainer if I had never taken out a patent. However, you must not think from this that I have not made money, but I have made it as a manufacturer and not as an inventor. My different inventions now furnish employment for 100,000 men, and this number is constantly increasing." "You speak somewhat harshly of the American patent laws," interjected the interviewer. "And with reason," broke in Mr. Edison with emphasis. "No sooner does an inventor make known some important mechanical discovery by applying for a patent, than a pirate comes along and steals it. Years pass before the case comes to trial, and in the meantime the practice of the courts gives the pirate the benefit of the doubt. Many patents are decided in the inventor's favour only when the patent is about to expire, and has therefore become almost worthless. This is all wrong. The courts should give the man who first secures a patent or first makes application for it the benefit of the doubt until the question of priority has been finally settled." Interrogated as to the general tendency of invention in the near future, Mr. Edison said that for many years to come inventions would deal in the main with securing greater economy of motive power. He added: "The turning of coal into motive power without the mediation of steam will be one of the next great triumphs of the inventor. I have for some years been at work on the problem of turning coal directly into electricity. I have clearly demonstrated that this can be done, and it now remains to be seen if it can be done at a profit. It would be a great thing if we could run a steamship or a locomotive engine for one-sixth of what it now costs, but I believe it can be done."

The Royal Society and Lord Kelvin.—The anniversary meeting of the Royal Society was held on Saturday last at Burlington House, W., when the president, Lord Kelvin, delivered the anniversary address. In the course of his remarks, he said that since the last anniversary meeting the Royal Society had lost 19 Fellows and seven foreign members. In Cayley they had lost one of the makers of mathematics, a poet in the true sense of the word, who made real for the world the ideas which his ever fertile imagination created for himself. He was the Senior Wrangler of his own freshman's year at Cambridge, and he himself well remembered to this day the admiration and awe with which, before the end of his first term, just 54 years ago, he had learned to regard Cayley's mathematical powers. When a little later he himself attained to the honour of knowing him personally, the awe was evaporated by the sunshine of his genial kindness; the admiration had remained unabated to this day, and Cayley's friendship had been one of the valued possessions of his life. At the good old age of 97 the veteran Franz Ernst Neumann had left them. He had been one of the most profound and fertile of all the workers in mathematical physics of the nineteenth century. Lord Kelvin then referred at length to the decease of Prof. Huxley and of M. Pasteur; and, in conclusion, he thanked all his colleagues of the Royal Society for electing him five times to be their president. In the evening the anniversary dinner of the Royal Society was held in the Hôtel Metropole, when the newly-elected president, Sir Joseph Lister, occupied the chair. A large and distinguished company sat down, the list of Fellows and guests present including the Italian Ambassador, the President of the Académie des Sciences, Lord Kelvin, Sir Gabriel Stokes, Mr. Ritchie (President of the Board of Trade), Sir D. Galton, Mr. Shaw Lefevre, the President of the Institution of Civil Engineers, Lord Rayleigh, Prof. Kennedy, Prof. Rücker, Prof. Ewing, Prof. Dewar, Prof. S. P. Thompson, Sir H. E. Roscoe, Prof. Roberts-Austen, Prof. Ramsay, Mr. Wolfe Barry, and Mr. Preece. Mr. Shaw Lefevre, in proposing the toast of the "Royal Society," said that in Lord Kelvin they had as president the greatest physicist of the day, and in his successor they had the greatest biologist of this country. Sir G. Stokes, in proposing the health of the retiring president, said that he knew Lord Kelvin very shortly after he took his degree at Cambridge, when they used to interchange ideas with one another on mathematical and physical subjects. He need not dwell on the eminence to which Lord Kelvin had now risen, but those who had the privilege of his acquaintance knew that it was not only for qualities of intellect that he was so remarkable, but also for qualities of heart. He hoped that now he was relieved from the cares of office, and enjoying the greater freedom that would come to him in the future, Lord Kelvin would continue to engage in the scientific researches with which he had been so long connected, and that he would yet be spared for many years to promote the cause of science in this country. In reply, Lord Kelvin said he was powerless to express his feelings after what Sir G. Stokes had said, and after the kind manner in which the toast had been received. He had now for more than 50 years looked upon Sir G. Stokes as his master in science. When an undergraduate at Cambridge, having himself some ideas on scientific investigation, his perpetual wonder was how Stokes chose to work on such infinitely difficult subjects. He could not understand the work he was doing. He could only admire; and still, whenever a difficulty occurred to him, it was to Sir G. Stokes that he must go for light and leading. To have succeeded Sir G. Stokes, and to have been president of the society for five years, was indeed the crowning honour of his life. Previous to this the medals of the society had been presented as follows: The Copley Medal to Prof. Karl Weierstrass, For. Mem. R.S. (received on his behalf by the foreign secretary), for his investigations in pure mathematics; a Royal Medal to Prof. James Alfred Ewing, F.R.S., for his investigations on magnetic induction in iron and other metals; a Royal Medal to Dr. John Murray, for his services to biological science and oceanography in connection with the "Challenger" reports, and for his original contributions to the same; and the Davy Medal to Prof. William Ramsay, F.R.S., for his share in the discovery of argon, and for his discoveries regarding gaseous constituents of terrestrial minerals. The following is a list of the officers and council elected for the ensuing year: President, Sir Joseph Lister, Bart., F.R.C.S., D.C.L.; treasurer, Sir John Evans, K.C.B., D.C.L., LL.D.; secretaries, Prof. Michael Foster, M.A., M.D., and Lord Rayleigh, M.A., D.C.L.; foreign secretary, Mr. Edward Frankland, D.C.L., LL.D; other members of the council: Mr. William Crookes, Sir Joseph Fayrer, K.C.S.I., Mr. Lazarus Fletcher, Mr. Walter Holbrook Gaskell, M.D., Mr. William Huggins, D.C.L., Lord Kelvin, Prof. Alexander B. W. Kennedy, LL.D., Prof. Horace Lamb, Prof. Edwin Ray Lankester, Prof. Charles Lapworth, LL.D., Major Percy Alexander MacMahon, R.A., Prof. John Henry Poynting, D.Sc., Prof. Arthur William Rücker, Mr. Osbert Salvin, Prof. Harry Marshall Ward, D.Sc., Admiral William James Lloyd Wharton, C.B.

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SHREWSBURY ELECTRICITY WORKS.

Politicians with a certain trend of mind say Englishmen are, as rule, conservative. We prefer to think it really is so, and that the proletariat and socialist are importations rather than scions of the good old stock. Be this as it may, it is an undoubted fact that those who claim to be sons of England have a strange liking to read, hear, and think of their ancestors—to roam the streets and fields where history was made. Shrewsbury is one of those shrines with a most beautiful natural setting that lay claim to an historic renown which never fails in its appeal to the hearts of Englishmen. As far back as the time of Edward the Confessor, Scrobbes-byrig, or, as Domesday Book puts it, Sciropesberie, had 250 houses, with a resident burgess in each house, and five churches. This indicates that even in those remote times Shrewsbury was no mean city, and it played a great part in all the troublous times of English history from the reign of the Conqueror downwards. Here, again and again, before the final incorporation of Wales with England, the fierce and hardy Welshmen fought many a gallant fight. Many of the bloodiest conflicts of the Wars of the Roses and of the Civil War took place in this district, so that its position in history cannot be gainsaid. Then it was a centre of turmoil, now it is a centre of peace. Delightfully situated on the Severn, with its quaint and sometimes inconvenient streets, with its picturesque old houses, it has been just a little slow, so far as the local authority is concerned, in adopting the electric light. Its citizens, however, have shown their energy in patronising a private company to produce that which their councillors hesitate in doing. The electric lighting is consequently left in the hands of the Shropshire Electric Light and Power Company. This company was originally promoted by a few influential residents anxious to see electricity introduced into the town of Shrewsbury, and accordingly in the year 1891 the same was duly incorporated under the Companies' Acts, with power also to supply electricity to other towns in the county of Salop which might thereafter be selected.

The Corporation did not oppose the application of the company for a provisional order, which was accordingly granted to them by the Board of Trade. The area of supply under the provisional order includes "so much of the borough of Shrewsbury (Fig. 1) as lies on the north bank of the River Severn to the south and south-west of an imaginary line drawn from the north-west corner of the waterworks to Coton-hill, along Coton-hill to Cross-street, and along Cross-street to the point where the same is crossed by the bridge of the London and North-Western and Great Western Joint Railways, and thence to a point where the same river is crossed by the viaduct or railway bridge of the same railways, but excluding the railway stations, and so much of the borough of Shrewsbury as lies on the south bank of the River Severn, within a line drawn from the River Severn at the Boat House Inn to the Hanwood-road, and along the said road until it reaches Port-hill, and then down the lane from Port-hill to Rea Brook, and then along the said brook to the River Severn."

The compulsory area is much smaller, and is practically bounded by the ring of mains shown in the map. A more compact town—and hence a town more favourable to the adoption of the low-tension system—can hardly be found in the kingdom. The cost of the mains will therefore be relatively a small item compared with that in many towns, and it will be noticed that all the principal public buildings (shown in black on the map) lie closely around the supply station.

Gateway of Council-House, Shrewsbury, from the Courtyard.

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The contract for the erection of the station, the supply of the necessary plant, mains, etc., was placed with Messrs. Edmundsons, Limited, of Great George-street, Westminster. The various sub-contractors under this firm are mentioned in connection with the apparatus they supplied. The company retained the services of Mr. A. H. Preece, A.M.I.C.E., to report on the plans drawn up by Messrs. Edmundsons, Limited, and afterwards to supervise the carrying out of the work. Now the station is completed and the work passed, Mr. Preece has presented a report to the company on the subject, of which we give the following abstracts:

"In the provisional order under which your company have all the necessary powers for the supply of electrical energy to Shrewsbury, the area specified as the compulsory area is most admirably situated for the first instalment of mains. It contains all the principal public buildings, hotels, shops, etc., and many other similar buildings are within easy reach. It is most essential to have a compact area, in order to prevent any large outlay of capital in copper mains. The money which has been spent in the mains, and which is the heaviest item in an electric lighting scheme of this kind, has been extremely moderate, yet it is fully able to comply with the demands of the compulsory area for some time to come.

MR. T. S. EYTON, CHAIRMAN, SHROPSHIRE ELECTRI LIGHT AND POWER CO

The system that you have adopted at Shrewsbury is that known as the low-pressure three-wire system. The two principal systems in use are the high pressure and the low pressure. There are many diverse opinions on the advantages and disadvantages of these two systems, but I always maintain that the question which decides the system is purely a local one. The most convenient position for the generating station and the area to be lighted are the two essential points. I consider that your directors have been very wise in adopting the low-pressure continuous-current system. It is undoubtedly the best system for Shrewsbury. It will be, of course, an easy task to generate currents of higher pressure when it becomes necessary to serve districts lying some distance away.

"The great advantages of this low-pressure system are: (1) the use of accumulators, which enables the generating plant to be run only in the evening—that is, at times of heavy demand—and which also form a reserve in case of a breakdown in the generating plant; (2) the safety of the low-pressure current; (3) the adaptability of the continuous current for use in driving electric motors; (4) the great economy in production.

"*Prospects.*—I feel very confident that the electric lighting scheme at Shrewsbury will be most successful. There are already over 1,000 lamps connected and applied for. Shrewsbury is a town with plenty of trade. There are many excellent shops and hotels, large public buildings, and good private houses. The success of electric lighting in other towns is certain to be followed by Shrewsbury. The great point is to keep the capital expenditure at a minimum and to get most out of the generating plant, and especially out of the mains. I see

MR. W. W. NAUNTON SECRETARY TO THE COMPANY.

no reason why this cannot be done at Shrewsbury. The present capital expenditure is small, and the area already served by the mains is the best and most compact that any town could have. The population of Shrewsbury is some 27,000. There are already towns of this size which have established electric lighting installations, and which are a great success. I feel convinced that as soon as you are able to obtain 4,000 lamps connected to the mains, a good profit will be made on the capital expenditure."

MR. J. C. WIGHAM, RESIDENT ENGINEER.

Mr. Preece's report also contains a short description of the plant, which, together with the figures as to probable cost, etc., we have been compelled to leave out.

The generating station is situated in Eagle Foundry-square, which, in addition to a foot approach through a passage leading from Pride-hill, known as "Seventy Steps," possesses also the advantage of an entry to the works by a convenient level roadway direct from the railway depôt for

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delivery of coal, removal of refuse, etc. The approach down the Seventy Steps is quite a feature in the characteristics of Shrewsbury. A small alley which would be taken for a private passage leads to the head of 70 precipitous steps down the hillside, which will afford a good test as to the sobriety of the staff generally. The buildings were designed by and erected under the superintendence of Mr. A. E. Lloyd Oswell, architect, of Shrewsbury, the contract for the same being entrusted to Mr. Henry Price, builder, of Welsh Bridge, and consist of boiler-house, engine-house, battery-house, offices, stores, and chimney stack 132ft. high. Some difficulty was experienced in obtaining satisfactory foundations for the latter, as, after excavating some 23ft. down through loose material, water was struck, which threatened to stop the work. It was, however, kept under by means of a steam-pump working night and day. Some 3ft. lower a shelving rock was found which would support the chimney on the

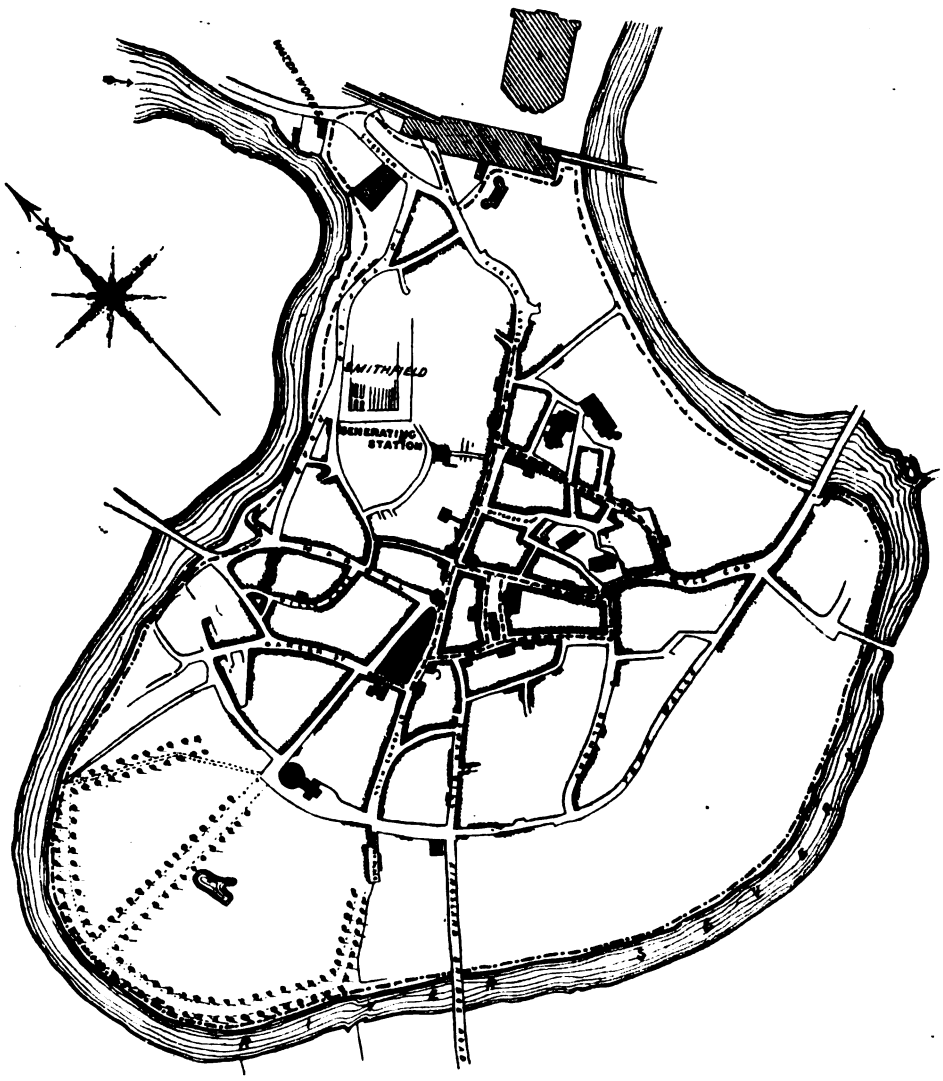

FIG. 1.—Map of Shrewsbury, showing Mains, etc. — · — · — · — denotes Main, and ● a Feeding Point.

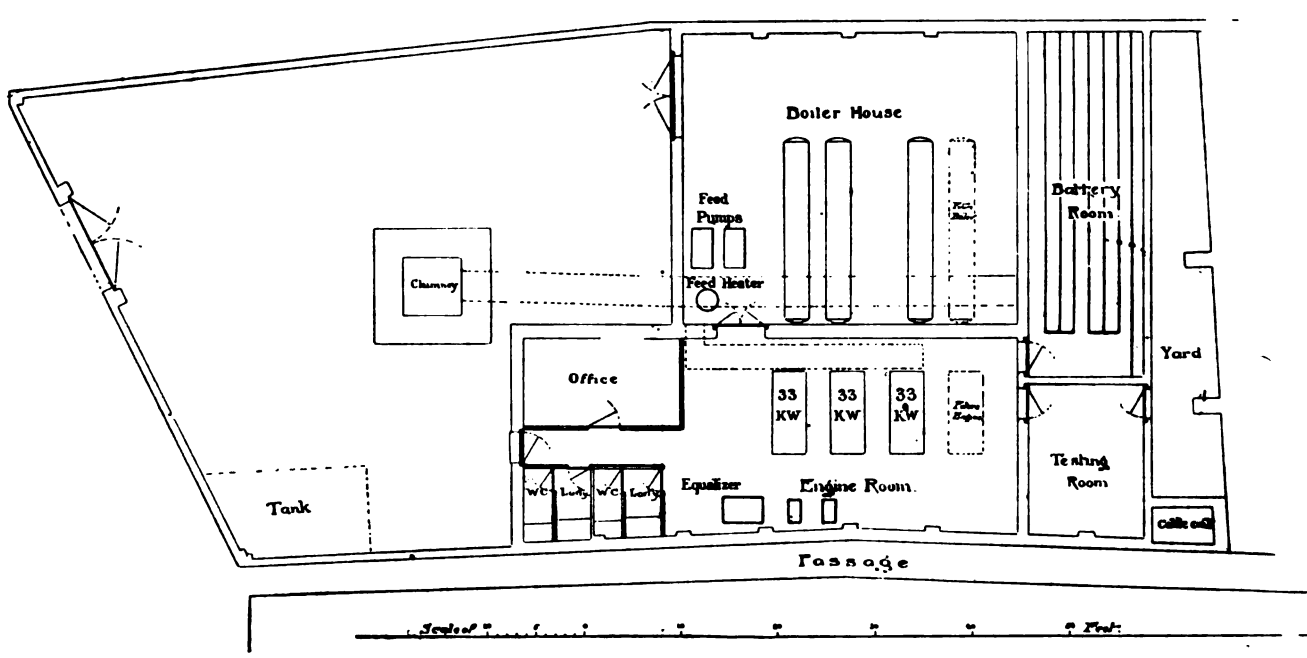

FIG. 2.—Plan of the Shrewsbury Electric Light Station, showing General Arrangement of Plant.

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inside. As the rock did not extend towards the river, it was decided to pile that side of the site. A 5ft. layer of cement concrete was then laid down over the pile heads and mortised into the rock, and on this the stack was built. The actual height of it from the concrete foundation is 132ft., but only 110ft. of this is above the entrance of the boiler flue. The shaft is 5ft. square inside throughout its entire height. The present buildings are designed to accommodate without alteration sufficient plant to supply 5,000 8-c.p. lamps simultaneously.

The general arrangement of the station and plant is shown in Fig. 2, the various machinery being indicated diagrammatically.

Steam Generating Plant.

The whole of this has been supplied by Messrs. Babcock and Wilcox, Limited. Three of their tubular boilers are at present fixed, each having 593 square feet of heating surface, two of the boilers being set together in one battery.

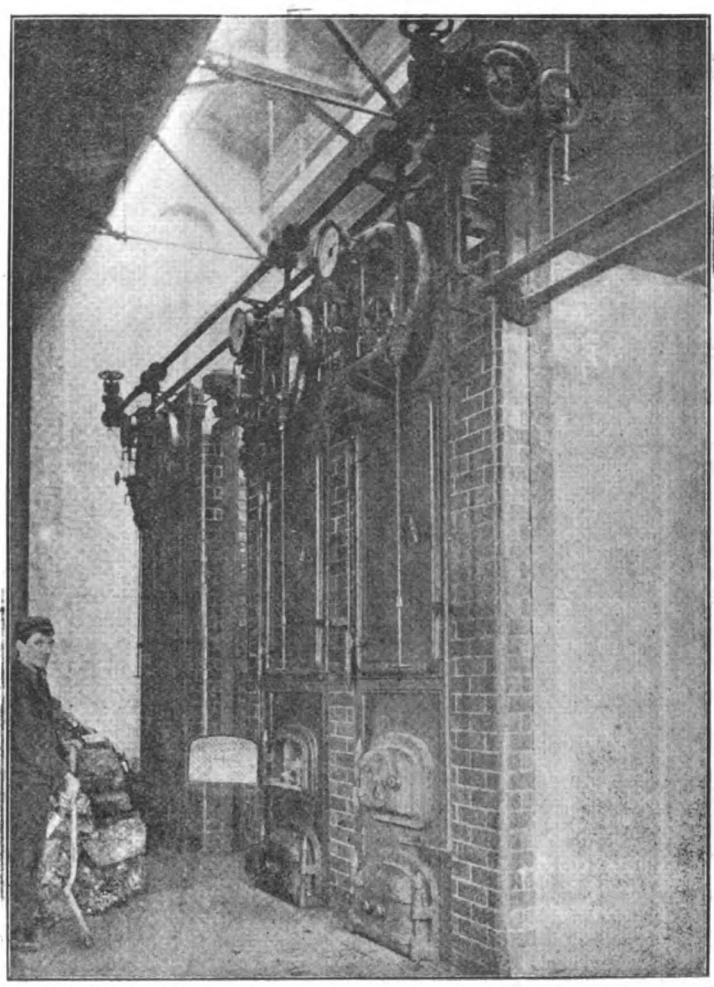

Fig 3.—View of the Boiler-House.

The remaining one is set by itself (Fig. 3), but is so arranged that a fourth boiler can be added at any time required. Each boiler is composed of four sections of tubes, each section being made of eight tubes 14in. long and 4in. in diameter. The steam and water drum is 30in. diameter and 19ft. 2in. long. It is fitted with Turnbull's dead-weight safety-valve, two angle feed-valves with long spindles, large main steam stop-valve, and the necessary blow-off cock, combined feed and check valve, water-gauges, etc. The manhole is arranged in the boiler shell, and the blow-off pipe is bent so as to come 6in. below the floor level. Each boiler works at 120lb. per square inch, and was tested after erection to 200lb. per square inch. There are two Worthington feed pumps 4½in. × 2¾in. × 4in., and the steam-mains to them are so constructed that steam can be taken from any one boiler should the others be standing. The pumps can each supply 5,400lb. of water per hour to the boilers.

The feed water, which is taken from the town supply, is passed through an exhaust feed-heater, also manufactured by Messrs. Babcock and Wilcox, Limited. This heater (Fig. 4) is designed on the water-tube principle, similar to the boilers; all the tubes are perfectly accessible for cleaning and inspection by merely removing the covers at the top and bottom of the heater, and as the tubes are straight they are readily cleaned by means of tube brushes and scrapers. Moreover, as the feed water enters at the top of the heater and leaves at the bottom the tendency is for any impurities in the water—such as dirt, or the carbonates and sulphates of lime and magnesia, which become insoluble when water is heated—to pass with the current of water into the bottom chamber, from which they are readily blown off by means of the cock fitted for that purpose. The construction of the heater tends greatly to prevent the adhesion of scale to the sides of the tubes. The heater is provided with a by-pass pipe, by which the exhaust steam can be taken direct to the atmosphere, if desired, instead of passing through the heater. The heater casing is only of light construction, as it has only to withstand the pressure of the exhaust steam, whilst the area allowed for the passage of the exhaust steam around the tubes is considerably greater than the area of the exhaust-pipe, which effectually prevents any back pressure being thrown upon the engine, a fault which is common in types of heaters in which steam is passed through the tubes instead of around them. The tubes are expanded into heavy mild-steel end-plates, and should a new tube at any time be required it can easily be inserted and expanded by any ordinary mechanic. There are 36 of these brass tubes, each 1½in. diameter and 5ft. 11in. long, giving a total heating surface of 84 square feet. This feed-water heater is capable of heating from 5,000lb. to 5,500lb of water per hour up to about 200deg. F. A duplicate system of feed-water mains is supplied to connect the two pumps with the boilers. These mains are taken overhead (Fig. 3),

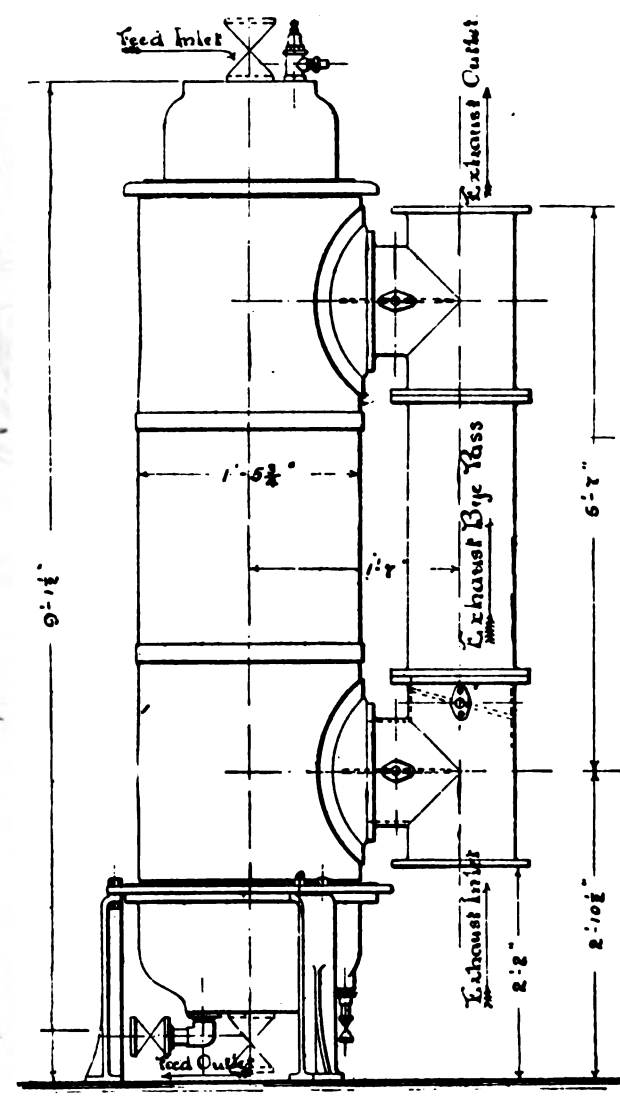

Fig 4.—The Babcock-Wilcox Exhaust Steam Feed Water Heater.

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and are arranged so that any boiler can be fed through either main by either pump, and that the water can either be passed through the heater or be fed direct into the boilers.

Steam and Exhaust Pipes.

These were included in the same sub-contract. The steam-pipes are arranged on the ring principle, the main being 4in. diameter. All the pipes are of wrought steel, with welded seams and wrought-steel flanges welded on. The T-pieces and pocket pipes, which can be seen in Fig. 5, are cast with a specially strong mixture of cast iron. The pocket pipes and the stop-valves on the engines are connected by the necessary drain-pipes to a Geipel steam-trap. The joints between the various pipes are made with corrugated brass rings. The exhaust-pipe is of cast iron, 8in. diameter, and connects the three engines with the feed-water heater. A by-pass valve is also arranged so that the steam can be discharged direct into a pipe in the chimney if required. The exhaust-pipe is laid in a trench round the foundations of the engines, the trenches being covered with wrought-iron chequer plates. The steam-pipe is suspended on long rods, so that it is free to expand. No condensing plant is provided at present, but when the station is extended it will be quite possible to obtain a good supply of water by sinking a well on the site. The parts of the steam-drum exposed to the atmosphere are lagged with a non-conducting composition 2in. thick, as are also the main steam-pipes, the steam to the pumps, and the feed-delivery pipes from the heater to the boilers.

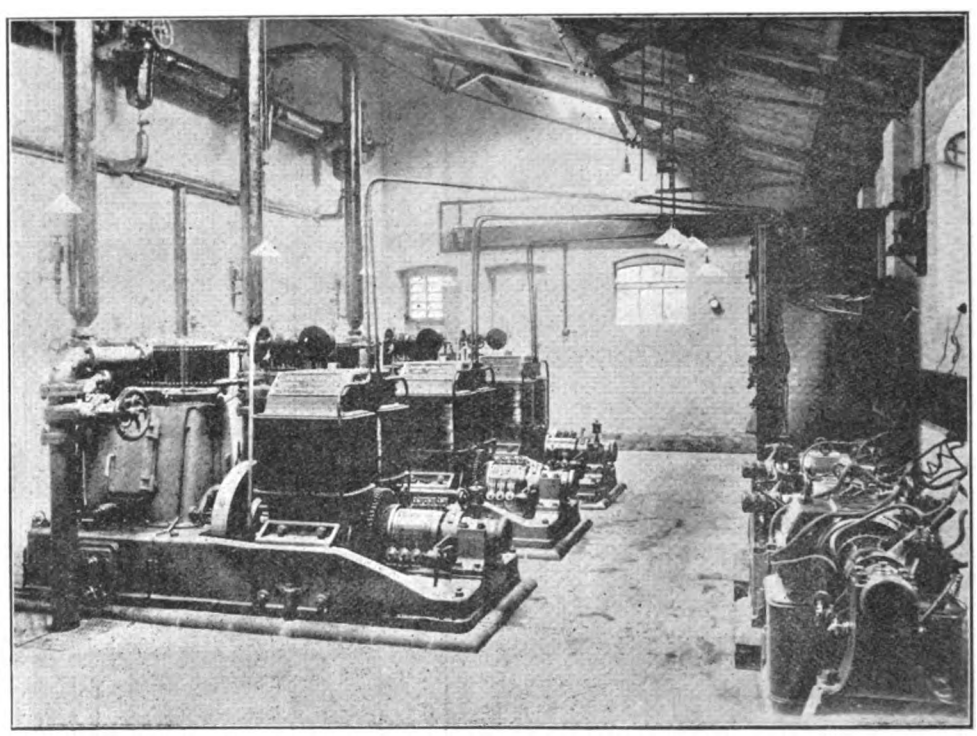

Fig. 5.—General View of the Engine-Room.

Engines.

These have been supplied by Messrs. G. E. Belliss and Co., of Birmingham. The engines are three in number, designed for an output of 49 b.h.p., at a speed of 500 revolutions, with steam pressure of 120lb. per square inch at the engine stop-valve. These engines are of the single-eccentric type of the closed-in type. The eccentric is placed between the two cylinders, and works both the high and low pressure valves, which are of the cylindrical type. The oil is supplied by means of a simple pump, without valves or packing, working off the eccentric from a well in the framing, and discharging at a pressure of about 10lb. through oil-channels into all working parts. The double action of the engine permits the film of oil, at this pressure, to get thoroughly between the working journals and brasses, keeping them apart and preventing any wear or chance of knocking with any load. The casing is fitted with a hinged door at back, to allow of free access for inspection and adjustment, and the whole front of the casing can be removed in a few minutes, if necessary, to overhaul the working parts.

The governors are well designed, and hold the engines in control in spite of sudden fluctuations of load, the increase of speed when the whole of the load is suddenly thrown off being only 3 per cent. Hand adjustment of the governors is, however, provided, which allows of a 15 per cent. variation of speed. This conduces to economy at light loads, as the speed can be reduced. Fig. 6 shows one of these engines coupled direct to a dynamo.

Electrical Machinery.

The sub-contract for this part of the outfit of the station was placed with Thomas Parker, Limited. There are three shunt-wound dynamos direct coupled to the Belliss engines. Each machine is capable of giving 150 amperes at 220 volts when running at 500 revolutions. The dynamos are drum wound with the patent Eickemeyer system, so largely used by Mr. Parker. The field magnets are of cast steel, the two limbs and yoke being one casting. This casting, however, terminates on the horizontal plane through the axis of the armature. The two other portions of the pole-pieces are separately attached to the brass supports, so that all the upper portions of the field-magnets with the shunt windings can be lifted off, leaving the armature exposed *in situ*. Sight-feed lubricators are used on these machines. The equaliser is connected across the two outside wires of the three-wire distribution to balance any excess current that may occur on either side. It consists of a duplex armature running in the ordinary type of field magnets. The number of turns in the two armature windings is the same, and each winding will stand 80 amperes at the pressure of 110 volts. The machine is provided with ring lubricator. The other two machines near the equaliser, shown diagrammatically in the plan, Fig. 2, and which can also be seen in Fig. 5, are "boosters" for providing the excess voltage required to charge the accumulators. They are constant-current transformers of the same general type as the equaliser, but the number of turns in the two windings on the armature have the ratio of 110 to 35. So the voltage is reduced in this ratio, and the 35 volts obtained by transformation are connected in series with the normal supply to charge the accumulators. There are two of these boosters—one for each set of accumulators. They run at about 1,000 revolutions per minute when fully loaded. The E.M.F. and charging

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current are regulated by a resistance in the primary circuit.

SWITCHBOARD.

The switchboard (Fig. 7) and all connections to it are also supplied by the above firm. The switchboard consists of eight panels of slate mounted on strong wood frames. Of these are three dynamo panels each fitted with an ammeter, a double-pole switch and fuse, and a 17-way switch and resistances for regulating E.M.F. of dynamos by varying the shunt current; two accumulator panels each fitted with an ammeter for charge and discharge circuit, two single-pole switches, a 12-way battery regulating switch, and starting and regulating switch with resistances for use with the charging transformer; one balancing transformer panel fitted with a double-pole switch, a transformer starting switch with resistances, and two registering ammeters which record the total output of the station; two feeder panels fitted with ammeters and fuses for four feeders."

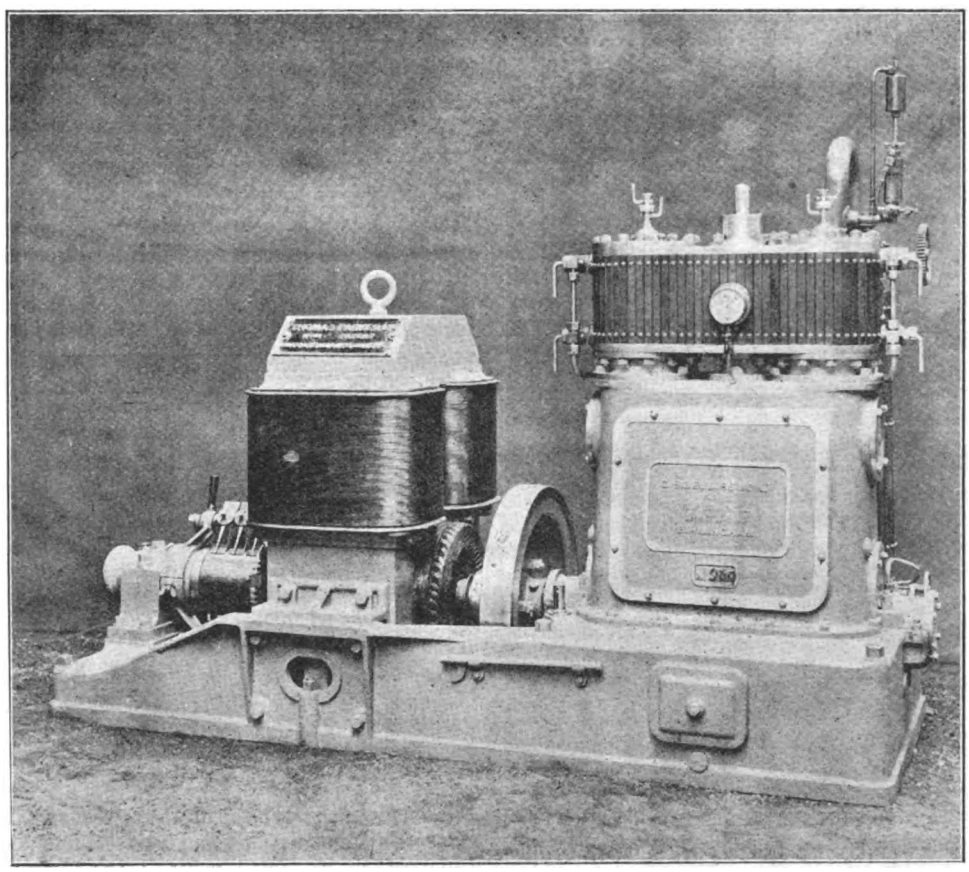

FIG. —The Bellias-Parker 33-K.W. Steam Dynamo.

METHOD OF WORKING.

All the 220-volt dynamos are coupled in parallel on to omnibus bars, from which the outside wires of the feeders take their supply of current. The centre wire of each feeder is brought back to a centre terminal in between the two armatures of balancing transformer and to the centre of the battery of accumulator battery, so that either the balancing transformer or the battery may be used for

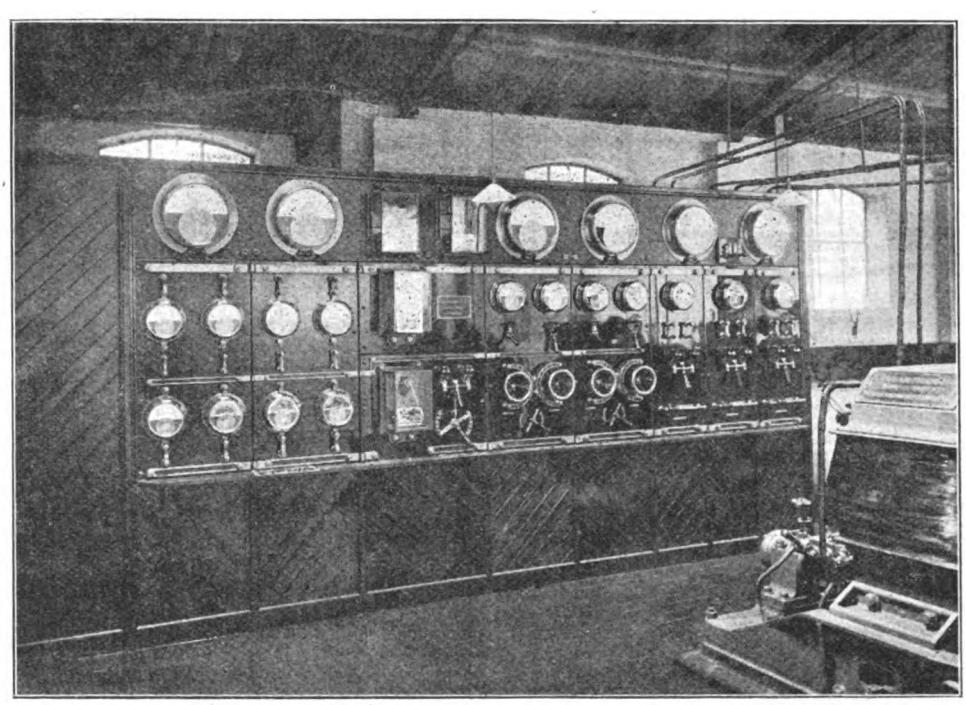

FIG. 7.—The Switchboard at the Shrewsbury Electric Light Station.

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supplying the excess current to balance the two sides of network. The batteries are charged as far as possible directly across the omnibus bars, the charging transformers being used for the latter portion of the charging only.

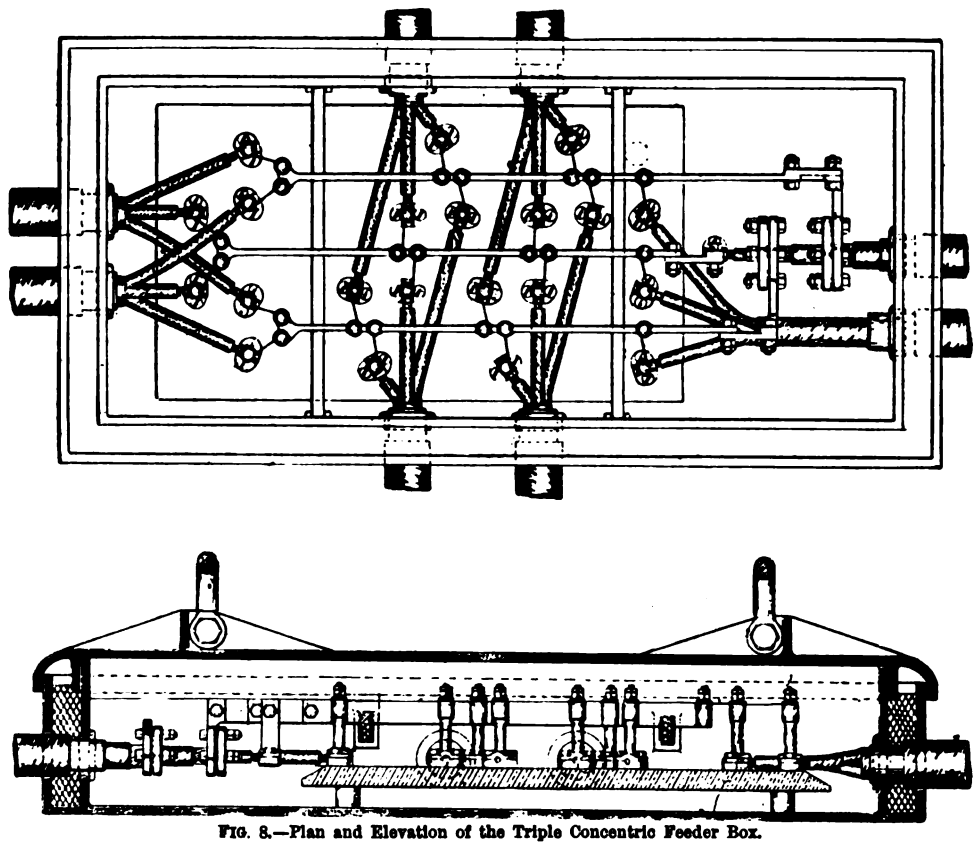

FIG. 8.—Plan and Elevation of the Triple Concentric Feeder Box.

ACCUMULATORS.

These are of the well-known D.P. type, and are supplied by the D.P. Battery Company. There are 110 cells, each containing 19 plates. These are connected all in series, the centre connection being made to the zero wire of the network. The capacity of battery is 500 ampere-hours.

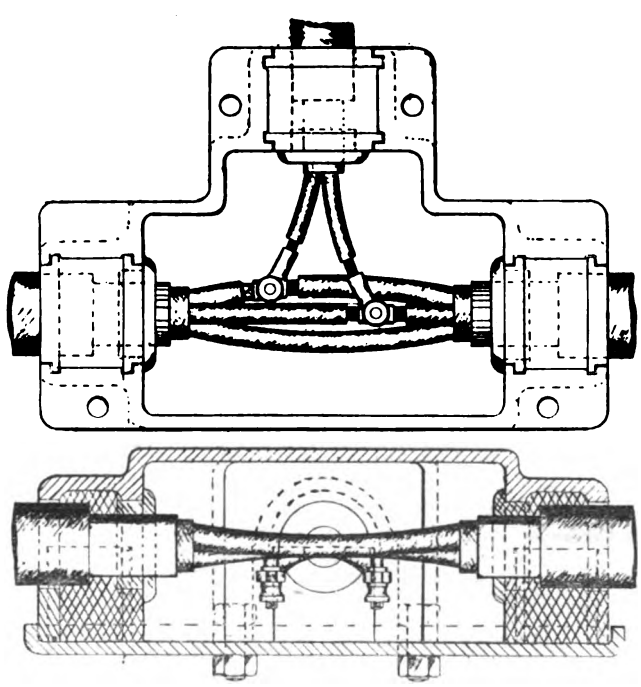

FIG. 9.—Plan and Elevation of House Service Box.

The cells are arranged in five rows on the floor of the battery-room, so that additional batteries can be arranged above them when required.

MAINS.

The whole of the cables which have been used in connection with the Shrewsbury lighting were manufactured by the Callender Bitumen Telegraph and Waterproof Company, Limited, of London and Erith, and laid by them under the charge of their resident engineer, Mr. A. Burton. The Callender Company undertook the whole of the street work, making all the necessary excavations and reinstatement of the roads and footpaths. In some parts of the town this was a work of considerable difficulty, especially at Seventy Steps, where great precautions had to be taken to prevent damage to existing buildings, many of which are very old. The whole of the cables are laid on the three-wire system, those used as distributors being of a special type. They consist of three conductors, each separately insulated and then stranded together, packed to a circular section, lead sheathed, and armoured. The feeder cables are of the ordinary make of triple concentric, the dielectric in each case consisting of bitumenised fibre, but the lead sheath which has been used is of an exceptionally heavy type.

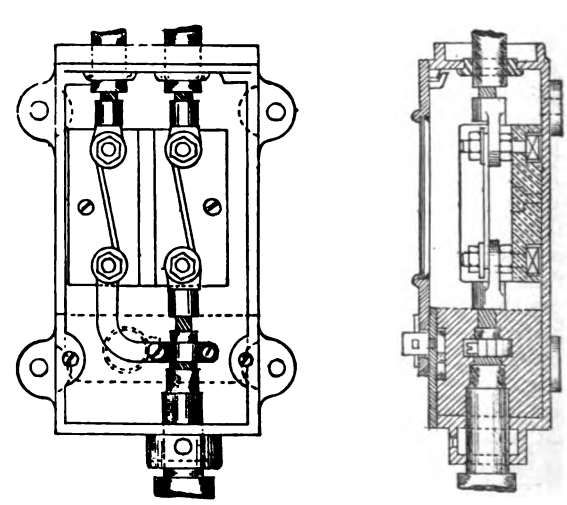

FIG. 10.—House Connection and Fuse Box.

The greater part of the distributors are of ·06 square inch sectional area, but in outlying streets a smaller size has been used, each conductor being ·035 sectional area. In some of the heavy portions of the town the size of the distributors has been increased to ·100 square inch section. The total amount of distributors now laid is over 2,500 yards.

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Five feeder cables are carried from the distributing station to the top of Seventy Steps; two of them at present end there, so as to be suitable for future extensions. The other three are carried to different points in the town, and are connected to the network, at the points shown in Fig. 1, by means of boxes, as shown in Fig. 8. It will be noticed that fuses are provided, so that in the event of any line becoming overloaded by a fault, either at the consumer's premises or on the mains themselves, it would be cut out of service. The space round the box through which the cables enter is cast in with bitumen to secure the cables in position. Then, after all the connections have been made, the box is filled up with a special compound till only the fuses project. This securely seals all the cable ends, and gives a good insulation to the system. Each of these boxes is set in a brick-built pit, which is closed by a cast-iron frame having a concrete cover. The boxes have been very strongly constructed. The consumers are connected with the mains by means of a service box, shown in Fig. 9. At the end of each consumer's line a fuse-box of the type shown in Fig. 10 is fitted. These fuse-boxes are fireproof, and are designed to meet the requirements which have now been insisted upon at the recent conference held by the Board of Trade at Westminster. The capacity of the feeders and mains at present laid down and connected are sufficient for 3,000 8-c.p. lamps burning at one time, or, say, 5,000 fixed in consumers' premises.

Mr. Preece, in his report speaking of this part of the work, says: "The whole of the mains have been laid down under my supervision, and have been thoroughly tested by me. They are fully up to the highest standard for this kind of work."

The opening ceremony takes place on Tuesday, the 10th inst., under the presidency of the Mayor of Shrewsbury. To popularise the light an electrical exhibition has been arranged, and will be opened by Mr. W. H. Preece, F.R.S., C.B.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE BOARD'S PROPOSED REGULATION ON TESTING ELECTRIC SUPPLY SYSTEMS.

SIR,—Major-General Webber in your issue of last week amplifies the criticism he made at the Board of Trade conference with respect to Rule 10, which provides for periodical insulation tests of every complete circuit used for the supply of energy, and he assumes "want of experience" on the part of those, who like myself, supported the proposed rule. I cannot help thinking that General Webber has failed to realise the object of the rule or the advantages to be gained by its observance.

If it be assumed that defective insulation may be a source of danger, either to the public or to the maintenance of an efficient service, it surely must be obvious to anyone with any practical experience of central-station work that it is quite immaterial whether the defect is on that part of the circuit belonging to the undertakers or on that part belonging to the consumer. The test that is required is the test of the *complete circuit*, as proposed by the Board of Trade and supported by Mr. Preece at the conference.

As the result of many years of central-station work in Liverpool we have long since adopted for our own protection *hourly* tests of the insulation resistance of the complete circuits supplied from each of our stations. These tests generally show an insulation very much higher than that prescribed by the Board of Trade rule, which limits the leakage to one-thousandth part of the maximum supply current. If the hourly test of the whole of the connected circuits shows any failure of insulation, we are able by a special device to trace which of the individual circuits supplied from the station is faulty.

The above tests are made without any disconnection of mains or interruption of supply, but when a faulty circuit has been detected in this way it is, of course, necessary to examine it in detail to ascertain whether the fault exists on any portion of the company's mains, or, as is more frequently the case, on the consumers' premises, and this part of the work is carried out at such hours of the day or night as may cause least inconvenience to the consumers affected. Insulation tests limited to the undertakers' portion of the circuit, as suggested by General Webber, would be practically useless for the purpose intended. In Liverpool, all mains have an insulating covering throughout, but in Birmingham, where exactly the same system of testing is adopted, the mains include a considerable length of bare copper conductor.

My chief object in troubling you with this communication is to express the hope that the great consideration and courtesy shown by Sir Courtenay Boyle and his advisers to those interested in the supply of electrical energy will be appreciated by engineers responsible for supply stations, and that they will support the Board of Trade in making such rules as are calculated to secure real efficiency.—Yours, etc., A. BROMLEY HOLMES.

THE LIGHTING OF RAILWAY CARRIAGES.

SIR,—We have read with interest the article in the current number of your journal of our new system for the electric lighting of railway carriages. We would point out to you, however, that your remarks concerning waste of power due to the slipping of our driving belt do not at all agree with the results of our practical experience. We shall be pleased if you will call at our works in the course of the next few days, when we will practically demonstrate to you that the figures you gave with regard to this matter were based on a misconception. We shall also be pleased to afford you a more convenient opportunity for fully inspecting our apparatus than could be given at the trial run last week.—Yours, etc., J. STONE AND CO.

[We shall be most pleased to accept Messrs. Stone and Co.'s invitation to investigate this most interesting subject.—ED. *E. E.*]

(For remainder of Correspondence see page 655.)

WHAT, WHEN, AND WHERE.

Institution of Civil Engineers.

December 10, 8 p.m.—Ordinary meeting. Discussion on the papers by Messrs. Arnold and Wrightson on "The Physical Properties of Iron and Steel."

Physical Society.

December 13—1. "A Mechanical Device for Performing the Temperature Corrections of Barometers," by Dr. John Shield. 2 "On the Existence of Earth-Air Electrical Currents," by Prof. Rücker, F.R.S.

Institution of Electrical Engineers.

December 12, 8 p.m.—At 25, Great George-street, Westminster. Annual general meeting. Also discussion on "The Electric Wiring Question," paper by F. Bathurst; and on "Concentric Wiring," paper by Saml. Mavor.

Society of Arts.

December 9, 8 p.m.—Cantor Lectures, "Mechanical Road Carriages," by W. Worby Beaumont, M.I.C.E. Lecture II.

December 11, 8 p.m.—Fourth ordinary meeting. Adjourned discussion on Mr. Cunynghame's paper on "Locomotive Carriages for Common Roads."

Northern Society of Electrical Engineers.

December 9.—At the Palatine Hotel, Hunt's Bank, Manchester. Council meeting at 7.15 p.m.; annual general meeting at 8 p.m. Election of council and officers. "Test of a Colliery Hauling, Pumping, and Lighting Installation," by C. H. Lees, D.Sc., Owens College.

Chesterfield and Midland Counties Institution of Engineers.

December 7, at 3 p.m.—At University College, Nottingham, General meeting. The following papers will be read or taken as read: "Fencing Gates for Winding Shafts," by William Hay; "A Boring below the Blackshale Coal at Apperknowle, near Sheffield," by G. E. Coke. The following papers will be open for discussion: 1894.—"Report of the Flameless Explosives Committee of the North of England Institute: Part I., Air and Combustible Gases," by A. C. Kayll (adjourned from Leicester meeting, January 26, 1895). December, 1894.—"An Underground Endless Rope at the Moston Colliery, Manchester," by H. Richardson Hewitt (adjourned from Nottingham meeting, March 16, 1895). March, 1895.—"Banking, Screening, and Mechanical Arrangement for Direct Sorting and Packing Coal,' by William Hay (adjourned from Nottingham meeting, March 16, 1895). July, 1895.—"Photometric Value of, and Notes upon, Various Illuminants Used in Mines," by A. H. Stokes (adjourned from Chesterfield meeting, October 12, 1895).

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THE
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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. XV. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers or binding can be obtained, price 2s.

THAT MUNICIPAL ENGINEERS' SOCIETY.

It is with regret we find the acting spirits in the formation of this society have not yet learned wisdom. They still insist upon electing as honorary secretary a man outside their own body—and connected therewith simply as a business man to sell them goods. This act will be absolutely fatal to the success of any such society, and will have the effect, instead of raising the position of electrical municipal engineers to the level of gasworks managers or waterworks engineers, of degrading them to the position of those who play into the hands of salesmen. It is no use mincing words. Business men do not undertake secretarial work of this kind for nothing. It is impossible to imagine the waterworks engineers—who, by the way, are also about to form an association, the first meeting of which will be called at Nottingham early in January—electing a man as secretary—call him honorary or otherwise—whose aim in life is to sell them goods. What has a commercial traveller to do with the inner working of municipal engineering? No doubt his place is to know and be on friendly terms with every electrical engineer, but it is not, therefore, their place to make him their confidant. From what we have heard on the subject, we feel certain that the majority of municipal electrical engineers will repudiate the course of action taken at what must be designated a hole-and-corner meeting during the late conference. The notices for this meeting were sent out in such a manner that the greater part of the municipal electrical engineers' body had no opportunity of being present at the meeting in order to declare their opposition to such action. It rests with municipal electrical engineers to make their own position, and if they prostitute themselves into the hands of commercial travellers they must expect to be treated with scant respect. Regretting a mistake made in initial periods of action in future years will not mend matters. The time to take every precaution and to guard against every appearance of commercial trafficking is at these early stages. The going outside their own body to obtain a secretary is not the point in question; the error is in the selection of a commercial man with whom they must have business relations, and having them, any action of playing into his hands is likely to be misconstrued. We have no hesitation in saying that the commercial man's sole aim is self, and he would not be a good business man were it not so. Hence, as the real acting head of a society the aim of which is not buying and selling, he is out of place.

THE INSTITUTION.

The balloting list for the Council and officers for the year 1896 has reached us, and is given in another column. It will at once be noticed that the Council have avoided joining issue with the organised opposition against placing the senior vice-president in the presidential chair. We have purposely refrained from referring to the matter in our columns up to the present. We hold that the candidate for the highest honour the Institution can bestow should be held in such esteem by the general members as

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to render the ballot a complimentary form. If, however, a gentleman is proposed who does not meet with general approval, the opinion against him should, in our opinion, be expressed at the ballot only. The opposition should only direct its aims to arranging that all adverse votes are placed in one direction only. The agitation which has been everywhere felt on the subject during the past month can only bring discredit on the profession as a whole. We cannot, therefore, regard the present list with satisfaction, because it practically assumes that the whole matter will again be brought forward at the annual meeting in 1896. The rearrangement of the vice-president list is also unsatisfactory, as we find the gentleman who certainly best represented the general engineering side has been unceremoniously struck off to make room for another representative of the professional class, which already carries undue weight on the Council. We would wish rather to see the importance of central-station engineers more acknowledged by the inclusion of at least one more of their number on the Council.

THE PRESIDENTIAL ELECTION.

SIR,—A committee, of which we were invited to act as honorary secretaries, was recently formed of the members of the Institution, representative of all sections of the industry, to give effect to the views of a large number of members and associates on the subject of the forthcoming election of president. It was considered that in the interests of the Institution the president should be a man pre-eminent in electrical science or electrical engineering, and that the presidency should not necessarily be a matter of rotation among the vice-presidents.

The balloting list issued by the Council for the year 1896, which is now in the hands of the members and associates, indicates that the Council, in nominating Dr. John Hopkinson for election as president, share the same views. It is believed that in abandoning an undesirable custom, the Council have acted in sympathy with the general wishes of members of all classes, and that the selection of Dr. Hopkinson will meet with the unanimous approval of the Institution.—Yours, etc.,

R. S. ERSKINE
A. A. C. SWINTON } Hon. Secretaries.

December 4, 1895.

COUPLING DYNAMOS IN PARALLEL.

SIR,—I would feel much obliged by your informing me, through your columns, if it is permissible to join up in parallel a shunt-wound dynamo (130 volts 120 amperes) and a compound dynamo (110 volts 275 amperes) to feed one circuit; also what would be the result of this combination with regard to mutual effect, etc., each machine being speeded properly?—Yours, etc. REACTION.

[With reasonable care in working, there is no objection to the coupling of a compound dynamo in parallel with a shunt provided the circuit to be fed is not subject to very large and sudden changes of load. The danger is that the shunt machine may overpower the compound at light loads and demagnetise the field. Without information as to the method of driving the above machines and the voltage required from them in parallel, it is impossible to answer the last part of the letter. In any case the distribution of the load between the two will have to be effected by hand adjustment.—ED. *E. E.*]

Erratum.—In the letter from M. Jean Rey on the "Qualities of Mangin and Parabolic Mirrors," printed in our issue of November 22, p. 581, there is a slight misprint. In the second column, p. 581, just above the diagram, for I/e read I/e^2.

CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XVIII.

(Specially Contributed.)

Post Office Pattern.—In the various illustrations the long light pointer must not be confused with the short needle. The needle must be kept short in order that it may be wholly in a uniform field, and, again, that its motions may not take it out of a uniform field, but most instruments are in some way furnished with long light pointers to assist the scale reading. Fig. 1 shows a plan of the

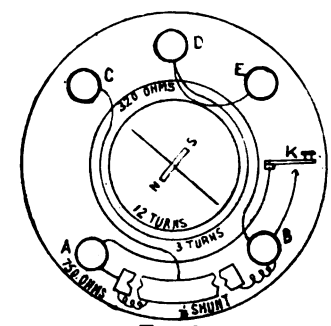

FIG. 1.

latest Post Office pattern of tangent galvanometer. Around the needle are really three coils—one of only three turns of wire of No. 18 gauge—*i.e.*, of 48 mils diameter—one of 12 turns of similar wire, and a third with a resistance of 320 ohms. The three turns end in the terminals C D, the 12 turns wound in the opposite direction end in the terminals D E. In addition to the coils of 320 ohms between the terminals A B, there is a resistance external to the galvanometer coil of 750 ohms, which can be used or not, as required by the test. There is also a shunt coil of one-tenth to the high-resistance coil. Let us consider the effects of these various coils. Schweiger showed that the influence of one wire was doubled by duplicating the coil and tripled by triplicating the coil, of course current remaining constant. Suppose, then, we are dealing with a current, C,

Call the effect of one coil {carrying current, C, round the magnet} x,
then " " two coils each " " will be $2x$,
and " " three " " " " " $3x$,
" " " twelve " " " " " $12x$.

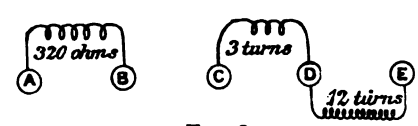

FIG. 2.

Perhaps the diagram, Fig. 2, will help us.

(1) If the conductor carrying current is connected between C D its effect will be $3x$.

(2) If it be connected between D E its effect will be $12x$, but the needle will move in the opposite direction to that it moved in case 1.

(3) If it be connected between C E we oppose three turns to the twelve turns, and so get $12-3=9$ effective turns, or an effect of $9x$.

(4) Alter the diagram a little, as in Fig. 3.

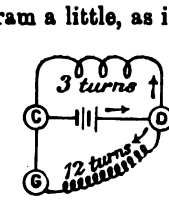

FIG. 3.—("G" on diagram should be "E.")

Join C E by a conductor whose resistance may be negligible.

We have a complete circuit.

Now put our current-carrying conductor between C D.

The current gets to D, splits up there to go by the two paths—viz., the three-coil path and the 12 coil path—and it splits up inversely as the resistance—that is, the biggest

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part goes by the line of least resistance, and the smallest part by the line of greatest resistance. Representing the total C by 15, then

12 parts out of the 15 parts will go by the 3 x coils,
and 3 „ „ „ „ „ „ 12 x coils.

That is $\frac{12}{15}$, or $\frac{4}{5}$ of the current goes by the 3 coils,
and $\frac{3}{15}$ „ $\frac{1}{5}$ „ „ „ „ 12 coils.

In this case the effect of the three-coil branch will be—
as $\frac{4}{5}$ C goes through each coil,
the effect of three coils on needle will be $3 \times \frac{4}{5} = \frac{12}{5}$ C;
as $\frac{1}{5}$ C goes through each of the 12-coil coils,
the effect of the 12 coils is $\frac{1}{5} \times 12 = \frac{12}{5}$ C.

And now both effects on the needle are in the same direction, hence the full effect is the sum of the two effects, or,

$$\frac{12}{5} + \frac{12}{5} = \frac{24}{5} \text{ C} = 4{\cdot}8 \text{ C}.$$

Fig. 4.

In this instrument (Fig. 4) the magnet is $\frac{3}{4}$in. long, and carries a pointer at right angles to it. When the poles of the magnet are parallel to the coil, then both ends of the pointer stand at zero on a graduated scale. Of course, there are two scales, one on each side of the instrument. One of the scales is marked off in true degrees, the other in numbers proportional to the tangent of those degrees, so that if two measurements give two deflections in degrees, the other end of the pointer will give approximately numbers proportional to the tangents of the degrees thus read. These numbers save much trouble, but it must be understood that for extreme accuracy it is best to refer to a table of tangents and obtain the values to more places of decimals. The scale numbers, once more, are approximate only.

The high-resistance coil is used in the measurement of small currents. Thus Kempe says: "In testing the strength of a current in milliamperes, the standard cell* is connected to A and B, and both plugs are removed from the plug-holes. There is then in circuit a total resistance of 1,070 ohms—viz., 750 + 320. As the E.M.F. of the cell is 1·07 volts, the resulting deflection of the galvanometer needle (which is adjusted by means of the adjusting magnet to 80 divisions on the outer scale) will be due to a current of

$$\frac{1{\cdot}07}{1{,}070} = {\cdot}001 \text{ ampere, or one milliampere,}$$

and any other deflection obtained with any particular current compared by direct proportion with the standard deflection will give the strength of that current in milliamperes.

"When the standard deflection is obtained the standard cell is removed, and the circuit from which the received current is to be measured is connected to terminal A, terminal B being put to earth."

Ballistic Galvanometers.—From what has been said it will be gathered that when a current is sent through the conductor ring, and continued constant, the galvanometer needle will be deflected, and come to rest in the deflected position. This is so. To increase the effect of a weak current field upon the needle, it is necessary to coil the conductor round the needle a number of times. In this, the ordinary form of galvanometer, the needle is made very light, but in cases where the duration of the current is brief, the reading of the galvanometer is taken, not from the position of permanent deflection, but by the "throw" or "swing" of the needle due to the magnetic impulse of the transitory current. A galvanometer used to measure the "throw" is called a ballistic galvanometer, and is made with a heavier needle, and so that the needle moves slowly to the point of furthest swing, which is thus easily read. Before the light needle of a galvanometer comes to rest, there is usually a considerable amount of oscillation around the point of rest. In using a ballistic galvanometer, the magnetic moment of the needle must be taken into account as well as the constant of the galvanometer.

Astatic Needles—Astatic Galvanometers.—It is very often convenient to have an instrument that need not compulsorily have its needle pointing magnetically north and south. To obtain this, it is necessary in some way to neutralise the earth's magnetic action upon the magnet. Prof. Cumming for this purpose used a magnetised

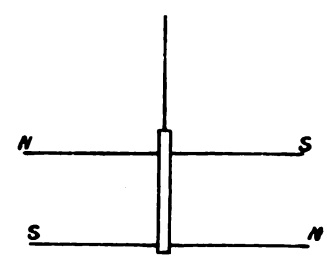

Fig. 5.

needle placed just below the movable needle. Nobili improved upon this by duplicating the needles, placing them one above the other, rigidly connected, parallel to each other, but with their poles in opposite directions, Fig. 5. It is almost impossible to have absolute astaticism, for this means two magnets of exactly equal strength with their poles in exactly the same vertical plane. If we could

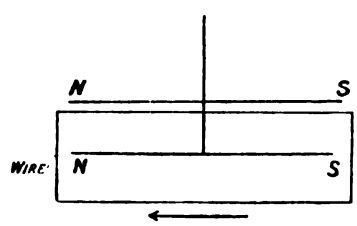

Fig. 6.

mechanically make such a system, then the earth's action on one needle would be exactly balanced by its action on the other needle, and the system would remain in whatever position it was placed without tendency to turn. It is

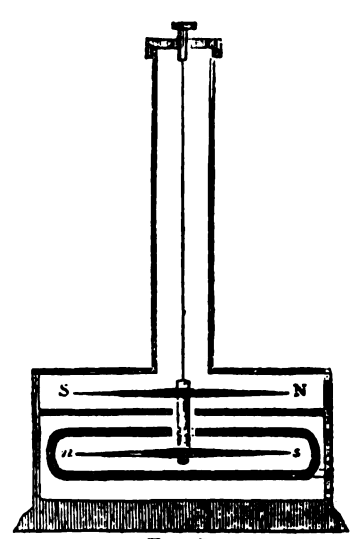

Fig. 7.

impossible to do this, so that instead of a perfect astatic system we usually get a system that acts as an exceedingly weak magnet, for if the needles are not exactly the same one can only set north and south by compelling the other

* This probably refers to a Daniell, not to a Clark cell.

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to set south and north. If, therefore, one does overpower the other, the system is held in the magnetic meridian much less strongly than would one needle be by itself. Usually the more astatic the system is the greater the tendency to set east and west, the reason of this being that one needle tries to pull the other north and south, whilst the other wants to pull it south and north. The nearer to equality the more they agree to differ, and set half-way to each other's discing. A perfect astatic system should point anywhere with no tendency to alter the position in which it is placed.

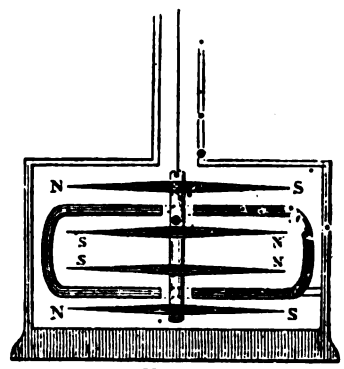

FIG. 8.

The principal use of the astatic needle is in the astatic galvanometer, in which the astatic system is deflected by a current through a coil similarly to the galvanometer needle previously mentioned. In the older instruments one of the needles is usually placed inside the coil, as shown in Figs. 6 and 7, the other outside. The current through

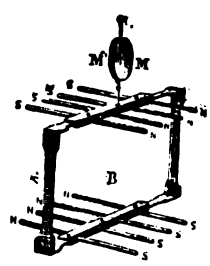

FIG. 9.

the coil will act so as to turn each needle of the astatic system in the same direction. Ampère's rule for the direction in which the needle will move has already been given. An extension of Nobili's galvanometer was proposed by M. Lebaillef, but it has been little used. He employed four needles, as shown in Fig. 8. Weber uses eight magnets, as shown in Fig. 9. The usual form of

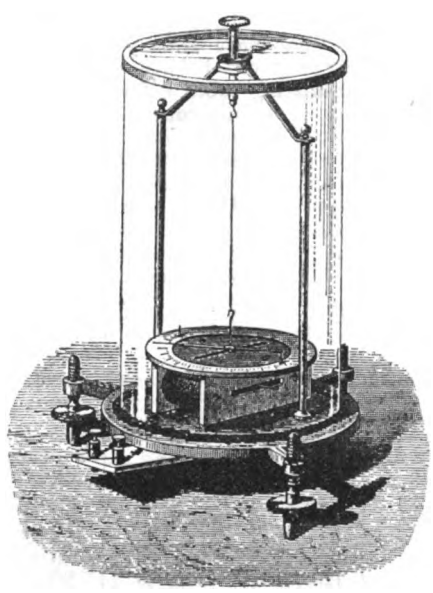

FIG. 10.

astatic galvanometer is shown in Fig. 10. The coil is wound upon an ivory frame, which also supports the circular scale, in the centre of which the upper needle is suspended. The ends of the coil are connected to binding screws, to which also the connections of the battery or other source of current can be made. The upper needle often carries a pointer, the more easily to read the scale correctly. The suspending fibre is fixed to a hook, which can be raised or lowered as required, so that when the instrument is not in use the system is lowered till the upper needle rests on the circular disc, and all strain is taken from the suspension. When using the instrument the astatic system is raised, and the levelling screws adjusted so that the needles swing quite freely.

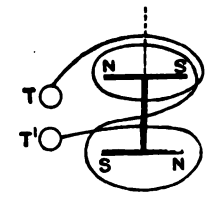

FIG. 11.

In the newer form of instruments, as we shall see, both needles are surrounded by the coils, as shown in Fig. 11.

INSTITUTION OF ELECTRICAL ENGINEERS.

The following is the balloting list for Council and officers for the year 1896 :

PRESIDENT.

Dr. John Hopkinson, M.A., F.R.S.

VICE-PRESIDENTS (*four to be elected*).

Sir David Salomons, Bart., M.A.
Sir Henry Mance, C.I.E., M.I.C.E.
Robert Kaye Gray, M.I.C.E.
Prof. S. P. Thompson, D.Sc., F.R.S.

ORDINARY MEMBERS OF COUNCIL (*12 to be elected*).

*Major A. H. Bagnold, R.E.
*Frank Bailey.
*G. von Chauvin.
*W. B Esson.
*S. Z De Ferranti.
*Prof. A. B W. Kennedy, LL.D., F R S , M I C E.
*William E. Langdon.
*Augustus Stroh
†Henry Edmunds.
†Prof J A Fleming, M.A., D.Sc., F.R S.
†Dane Sinclair
†J. W. Swan, F.R.S.

ASSOCIATE MEMBERS OF COUNCIL (*three to be elected*).

†Captain W. P. Brett, R.E.
†H. W. Miller.
†Sydney Morse.

HONORARY TREASURER.

Sir David Salomons, Bart., M.A. (Vice-President).

HONORARY AUDITORS.

Frederick C. Danvers, India Office, S.W.
Augustus Stroh

HONORARY SOLICITORS.

Messrs. Wilson, Bristows, and Carpmael, 1, Copthall-buildings, E C.

* Remaining on Council. † Recommended by Council.

THE ELECTRIC WIRING QUESTION.

BY FRED. BATHURST, ASSOCIATE.

(Concluded from page 621.)

With a tube complying with these requirements all possible electrical trouble is minimised, the insulation on the conductors themselves is protected from mechanical damage, and is enveloped in a preservative, rather than a destructive, element. Temperature changes are reduced to a minimum, and if the conduit resists acids, alkalies, and gases, the insulating material on the wire is so shielded that its life is indefinitely prolonged. It appears to me that the insulating tube does for "wiring" what the high-resistance incandescent lamp did for the "distribution" problem. I contend, therefore, that an insulating tube method of wiring will prove the ultimate solution of the "electric wiring question."

THE INTERIOR CONDUIT COMPANY'S SYSTEM.

Having now hit, as it were, every head within reach, by criticising to the best of my ability the existing systems, I am bound not only to apologise (as I do sincerely) to those whom my criticisms may have aggrieved, but endeavour to make some amends by setting up an idol of my own, which may give opportunity for retaliation. Accordingly, I have pleasure in showing

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a few samples of the insulating tubes manufactured by the Interior Conduit Company, of New York, in the belief that they represent the highest achievement yet accomplished in the production of the ideal tube. This method of wiring originated with Mr. E. H. Johnson. This name, from its connection with the Edison companies, will be familiar to many. The system and process of manufacturing the tube and accessories have been worked out by Mr. Johnson in conjunction with Mr. Luther Steringer and Mr. E. T. Greenfield as co-patentees. The insulating material employed is a specially prepared hydrocarbon of the bitumen class. The necessary strength in tube form is obtained by using a peculiar grade of fireproof paper material which admits of impregnation. The system provides perfect immunity from fire, durability of insulation, accessibility to concealed wires, and reliable service. It has had extensive practical test in America, and more recently in Germany, where its reputation for being the safest, least expensive, and most practical method of wiring is now established. Perhaps the best confirmation I can give of this statement is the fact that we already count, in various countries, some two million incandescent lamps installed in the three varieties of tube—"plain," "brass-covered,' and "iron-armoured"—and have yet to learn of the first electrical fire arising from its use. Risking the criticism of "advertising," perhaps the best course that I can take is to examine this system in regard to the five cardinal points before mentioned of safety, durability, convenience, accessibility, and economy.

Safety.

We have noted that danger arises from deterioration of the insulating material on the conductors, and that this can be prevented by enclosing the wires in insulating tubes. These insulating tubes, or internally insulated metal tubes, have, therefore, an immediate advantage over plain metal tubes. Again, when deterioration does take place in a plain metal tube, the tube itself becomes a conductor, and invites deterioration at many points. If insulated tubes are used (with two conductors inside), the deterioration on one only brings additional stress upon the other conductor at one point. The tendency in this case is to create a "short-circuit" at the spot affected. In these particular tubes a short-circuit presents no danger, as the materials of which they are composed will resist the burning effect of the arc. Many tests have been made, and in every case it has been found that the "arc" increased in length until it broke, and severed the circuit without further danger. Any "short-circuit" trouble, then, removes itself, and its injurious effects are confined entirely within the tube. Since the presence of moisture is the principal cause of "short-circuit," the use of these tubes is likely to minimise the occurrence of trouble, because the tube material is non-conducting in respect to heat, and extraneous changes of temperature fail to produce internal condensation. The use of insulating tubes will also remove the increased danger in respect of wires employed for heating or power applications which may be temporarily overloaded, and in respect of wires protected by a fuse which through careless replacement has been made too large. It may also be that insulating tube methods of wiring will render it possible to materially modify our present practice in respect to "fusing."

While on this question of safety, I should say that there is only one point not yet entirely settled. It is whether the two insulated conductors should be kept together or separated—whether one or two tubes should be employed. Owing to the real necessity with a wood-casing system of keeping the wires apart, some authorities urge that this construction should be applied to tube methods, and that a separate tube should be used for each wire. In alternating-current circuits it is essential to keep the wires close together, to prevent a drop in voltage from inductional effects. Clearly, therefore, in this case both wires should by preference be in the same tube. Since in England two conductors are already allowed in "compo" pipes, I do not here anticipate objection being made to this construction in respect of an insulating tube which is electrically perfect and equal to "compo" mechanically. Moreover, in those positions where mechanical strength is imperative the insulating tube can be supplemented by an iron or steel covering. I maintain that theory points to the advisability of placing both wires together, and so far the results of practice favour this view.

Durability.

As far as present experience has gone, it shows that the bitumenised tube will under ordinary conditions last indefinitely. It can safely be embedded in the lime-and-sand plaster used in ordinary building construction. I may mention that the present tendency towards fireproof building construction is bringing into use certain cements caustic enough to attack nearly any material coming into contact with them. The problem thus presented has been successfully solved by the introduction of the "brass-covered" insulating tube. The bituminous material used in these insulating tubes is inert in its nature, and exercises no deleterious influence on the insulating material of the wires themselves. It has sufficient mechanical strength to resist any damage except that inflicted by gross carelessness or design, and in the case of chance mechanical injury to the tube the "accessibility" it provides renders repair easy. In respect of permanence and durability, the advantage of placing the conducting wires in channels which predetermine their relation to any contiguous conducting bodies is, I think, beyond question. The mischief done to wood casing and "compo" pipe by rats and other vermin is, in the case of these tubes, entirely obviated. From the fact that such inroads are successfully resisted, it would appear that bitumen disagrees with a rat's digestive machinery!

Convenience and Accessibility.

I have met some contractors who argue that a "conduit" method is not so convenient as "wood casing" or "rigid" methods. It is possible this has been their experience from a limited trial. I have no hesitation in stating that when wiremen become even slightly proficient in handling the material, they will prefer to instal "conduits." At least, this has been the universal judgment in other countries. "Boxes" and "elbows" do not present insuperable difficulties, nor do the "runs," when the rigid conduit can be made temporarily flexible by the use of heat. A perfect system of wiring should not only give a suitable channel for the wires, but must provide for the convenient jointing of the tubes themselves, and also for "switch" and "lamp" outlets. It should admit of the multiplication of small circuits from convenient "centres of distribution," as this construction avoids the necessity of joints in the wire, and permits equalisation of the voltage throughout the whole installation. An architect ought to be able to lay out the system and provide in his plans for the electrical installation as completely and intelligently as he now provides for steam or gas utilisation. The system I advocate satisfies these requirements, for, after the conduits have been erected and all danger from mechanical injury has passed, the wires can be readily drawn into their respective channels, and connected up to suitable distributing blocks. There are numbers of existing installations where over 1,000 lamps are in use, and in which any wire is "accessible" at any moment.

Economy.

An insulating tube system is also economical. With trained workmen, we estimate saving from 25 to 50 per cent. in the labour of installation. Even though the tube itself is comparatively expensive, if wires suitable to it are employed the total cost of material will compare favourably with any other system. The insulating properties of these tubes is such as to provide, approximately, an additional "300 megohms per mile" insulation resistance to the wire. We are beginning to appreciate the fact that, although we provide a costly "600-megohm wire," after having installed a few hundred feet our tests indicate a total insulation resistance of only a few thousand ohms. An insulating tube system can assist us to obtain a more commensurable result. If a high-insulation test has to be obtained in wiring work, practical experience shows there is little doubt that an insulating tube, and its suitably insulated wire inside, is commercially ahead of a relatively heavily-insulated wire. Perhaps the limit of economy will be reached when we know how to "earth" perfectly, and can use a bare copper conductor within a metal-covered insulating tube.

Conclusion.

I have already trespassed too long upon your patience, and would now only express the hope that those—I believe there are several present—who have already used insulating tubes will state their experience. I have ventured my personal opinion that the insulating tubes before you are the nearest approach yet existing toward the ideal method of wiring, and I trust that the verdict of those who have tried them will support this view. If this be so, I ask that this Institution, in considering "the question of electric wiring," will, in any rules it may issue, give recognition to, and make due provision for, the use of insulating tubes.

APPENDIX B.

Table Showing the "Insulation Test" Required in Various Countries. (Compiled from Rules of Supply Companies and Fire Offices).

Voltage of Circuits not to exceed 250 volts.

Size of installation, wired complete.	Country. England (London)	America. (New York).	Germany (Cologne).	Austria. (Vienna).
Amperes.	Ohms	Ohms.	Ohms.	Ohms.
10	500 000	2,000,000	100,000	50,000
25	250.000	1,800,000	40 000	20,000
50	125,000	400,000	20,000	10 000
100	—	150,000	10,000	5,000
200	—	80,000	—	—
250	25,000	—	4,000	2,000
400	—	40,000	—	—
500	12,500	—	2,000	1,000
800	—	11,000	—	—
1,000	—	—	1,000	500
1,600	—	5,500	—	—

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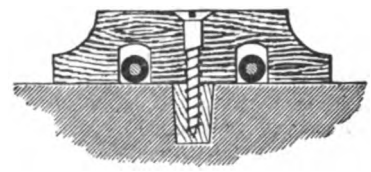
APPENDIX A.

DEVELOPMENT OF ELECTRIC WIRING.

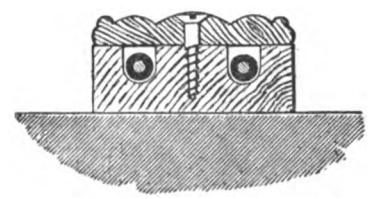
1. Wires secured on the surface by metal staples.

2. Wires directly embedded in plaster.

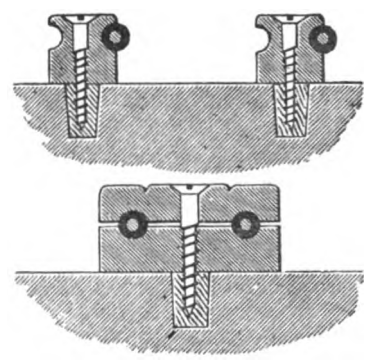
3. Wires secured on surface by wood cleats.



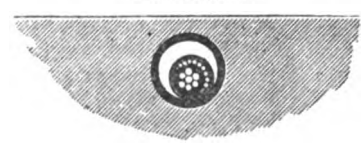
4. Wires secured on surface within wooden casings.



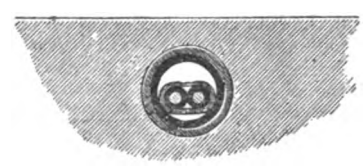
5. Wires secured on surface by means of porcelain knobs or cleats.



6. "Conduit" wiring beneath surface with twin (concentric) conductors.



7. "Armoured conduit" wiring beneath surface with twin (parallel) conductors.



APPENDIX C.

RESOLUTIONS ADOPTED AT THE MEETING OF THE UNDERWRITERS' INTERNATIONAL ELECTRIC ASSOCIATION, CHICAGO, AUGUST 17, 1893.

WHEREAS, under existing practices, but extremely few of the buildings in the United States which are wired are inspected before being closed in by lath and plaster; and

WHEREAS, an inspection after such closing in is incompetent and worthless, for the reason no means are known to the electrical profession by which the fire hazard of concealed or inaccessible circuits may be determined, and that a visual examination of all circuits must be had before immunity from fire hazard can be assured; and

WHEREAS, by the reason of non-inspection, the work of incompetent and irresponsible electricians remains for ever permanently concealed and uninspected, thereby affording ample opportunity for evading the requirements for safety, for practising gross impositions upon fire underwriters and the public, and imperilling millions in property valuations; and

WHEREAS, only through the use of insulating wireways is it possible to render concealed wiring permanently accessible; and

WHEREAS, such permanent accessibility renders it possible to thoroughly inspect at any time every installation so wired, and ensures trustworthy means for the detection of every piece of defective wiring of whatever nature; therefore, be it

Resolved, that the use of such insulating wireways for rendering concealed wiring permanently accessible be, and hereby is, most heartily endorsed and recommended; and be it further

Resolved, that such methods of accessible concealed construction be, and hereby are, advised for general use.

Resolved, that the secretary be requested to communicate with the American Institute of Architects, asking co-operation of their association in an endeavour to have architects when drawing plans for specifications make provisions for the channelling and pocketing of buildings for electric light or power wires.

Resolved, that they also be requested in specifications for electric gas lighting to require a two-wire circuit, whether the building is to be wired for electric lighting or not, and that no part of the gas fixtures or gas-piping be allowed to be used for the gas-lighting circuit.

THE ARC LIGHT.*

BY PROF. SILVANUS P. THOMPSON, D SC, F.R S.

LECTURE I.

(Continued from page 587.)

NON-ARCING METALS.

It has often been noticed that certain metals will hardly arc at all in a continuous way. If you take two solid cylinders of zinc or two cylinders of antimony and put them close together and connect them on to the electric light mains, and then start an arc by sparking across, the arc will not maintain itself. It splutters itself out instantly. This property has been made use of in America, where atmospheric disturbances are much more serious than in this country, for the purpose of constructing a non-arcing lightning arrester. Fig. 5 is a rough sketch of one form of this device. The inventor, Mr. A. J. Wurtz, made an exhaustive research to ascertain which of the metals do and which do not arc. He found that nearly all metals will arc,

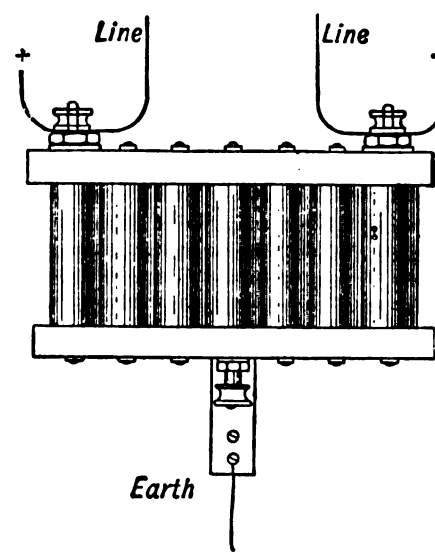


FIG. 5.

excepting zinc, antimony, and bismuth. Take the case of an electric station, working on an arc lighting system, supplying 40 or 50 lights in series. There is employed a potential of 2,000 or 3,000 volts. If a lightning flash were to start an arc from the outgoing line to the incoming line, it would set up a most destructive arc. In order to prevent any such catastrophe happening, there must be provided a lightning arrester. But the lightning arrester might go on carrying the arc if it were not made of non-arcing material. This is Wurtz's invention: a cylinder, made of a particular sort of brass, with a high percentage of zinc in it, is connected to one line, while another cylinder is connected to the other line. Between them—nearly touching one another—is a row of intermediate cylinders. The middle cylinder in the row is put to earth. Those on each side are not connected with anything at all, but merely fixed in a frame of stoneware or some non-conducting material. Then, if either of those lines is struck by lightning, there will be a momentary spark across those cylinders in series, and the discharge will go down to the earth instead of going to the power-house and deranging the machinery; but it will not persist as a continuous arc: the discharge will splutter itself out instantly. It is not precisely known why this effect occurs with the metals and alloys named and not with others.

TEMPERATURE OF THE ARC.

Until quite recently, the most wild guesses were all that could be learnt about the temperature of the arc, or of its various parts; such numbers as 10,000deg. C. and 500,000deg. F. were quite common. Becquerel, in 1860, suggested 2,070deg. C. to 2,100deg. C. as the probable temperature of the arc between carbons, his source of current being a battery of 80 Bunsen cells. In 1879 Rossetti published a research, based on observations of the radiation, in which he came, not without some doubts, to the conclusion that the respective temperatures

* Cantor lectures delivered before the Society of Arts.

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might be stated somewhat in the following terms: the temperature of the positive crater somewhere about 3,900deg. C., that of the negative peak about 3,1500deg. C. He concluded that the arc itself, although it gave, being gaseous, less light, was actually hotter, and he suggested 4,000deg. C. as being the best guess available. Rossetti's value of 3,900deg. C. for the temperature of the crater has been re-examined quite recently, in America by Nickolls, and in France by Violle. By two independent methods of measurements Violle arrived at numbers a little less, his final number at present being 3,500deg. C. He has arrived at this most recent measurement in a curiously direct way—viz., by a calorimetrical measurement. He arranged an arc in the following manner: The positive carbon was provided with a small end piece which at any moment could be knocked off and dropped into a calorimeter. This end piece was made the crater of the arc, and was allowed to burn away until it was quite thin; the supposition then being that it would nearly all be at the same temperature as its luminous surface. Then it was dropped off into the calorimeter, and the amount of heat it gave out in cooling was measured. The rather extravagant assumption had to be made, that the specific heat of carbon at this high temperature might be found by extrapolation from its known specific heat at lower temperatures; and the number arrived at agreed with the number derived from the observation of radiation. Mr. P. H. Gray has independently arrived at the value 3,400deg. So we may attribute a fairly reasonable accuracy to Violle's number, 3,500deg. We know that the lower carbon, the negative, is a good deal cooler. Violle's number for the negative carbon is about 2,700deg. C. He has recently brought forward evidence to show that the arc itself is probably hotter than either the positive or the negative carbon tip. That was previously a matter of inference from the nature of the radiations, spectro-photometrical observations being the basis. The new evidence is this: Make the arc using, not carbon, but a material which forms an arc at a lower temperature, zinc being the material in question. The temperature of the crater will, of course, correspond with the temperature of volatilisation of the zinc. Now, if into the flame between the positive and negative zinc tips you use some material which is less volatile or less fusible than zinc, you can again, by the aid of the spectroscope, satisfy yourself whether it is hotter or not. Violle found that the arc between the zinc poles could raise a piece of carbon to a temperature distinctly higher than that of either the positive or negative sides; consequently, by inference, the flame in the carbon arc is hotter than either of the two tips. It is to be hoped that other physicists will work at this question. There is really a great deal to be done on that part of the physics of the arc. Still more recently Violle has returned to the question whether the intrinsic brightness of the crater is independent of the strength of the current. His latest announcement is that when he took a very large piece of carbon, and made arcs with as small a current as 10 amperes, and as large a current as 1,000, the intrinsic brightness of the crater surface—that is to say, the amount of light emitted per square millimetre of surface—was the same.

Effect of Conductivity of Carbon Pencils.

If the pencils of carbon used are of insufficient cross-section or of a badly-conducting material, they will heat throughout their whole length, and waste an undue proportion of heat by offering a useless resistance to the current. From the point of view of economy a good-conducting quality of carbon is to be preferred. But, apart from the question of economy, the matter is of importance. If a pencil of insufficient section, in proportion to the current it must carry, is used as the positive carbon, the crater cannot be properly formed, and the arc will be more or less unstable, while the flame will lick around the rim. On the other hand, if the pencil is too thick relatively to the current, the crater will be very deep, and again the arc will burn unsteadily, as the crater shifts its place from moment to moment. For a 10-ampere lamp one frequently finds the positive pencil to be an uncored carbon 9mm. or 10mm. in diameter. If a carbon with a soft core is used, a slightly larger size is admissible. It is usual to employ for the lower negative pencil a carbon not cored, 1mm. or 2mm. less in diameter than the upper positive carbon.

If the carbon is of such poor conductivity, or so thin, relatively to the current it has to carry, as to become red-hot for more than a few millimetres beyond the luminous tip, it will waste by oxidation in the air, and become coned for a considerable length. A pair of such carbons are depicted in Fig. 6, at A. It was long ago suggested that the conductivity of carbons might be improved by plating them with a film of conducting metal. At B and C, in Fig. 6, are shown the forms assumed by carbons of the same quality, when they have been coppered or nickelled. The current flows freely down the external metal skin without materially heating the pencils along their length. In the immediate neighbourhood of the arc the metal is volatilised and disappears. Coppering is now seldom resorted to, as the carbon pencils of modern manufacture are of higher conductivity, and do not require to be coated. The conductivity of good moulded carbon pencils, such as are now used, is from 15 to 20 times as great as that of pencils sawn out of gas-retort carbon, being only from one-tenth to one-fifth ohm per foot of length. But coppering would reduce these values ten or twenty-fold.

Effect of Surrounding Gases on the Arc.

Another matter that has received extremely little attention is the effect on the arc of the surrounding medium. Until recently, it was not known what would be the effect of increasing the pressure of the air, or of surrounding the arc by different materials instead of atmospheric air. At a time before this 39 volts of back E.M.F. was as well recognised as it is now, it was supposed that this constant part of the voltage had something to do with the surrounding air; that, in fact, it was due to the oxygen and carbon combining. In order to disprove this notion, I had some experiments made three or four years ago with arcs burning in different materials, in chlorine, in coal-gas, in hydrogen, in nitrogen, etc. I found that it did not make one volt difference what the surrounding gas was. The 39 volts were still required as the minimum E.M.F. for a steady arc.

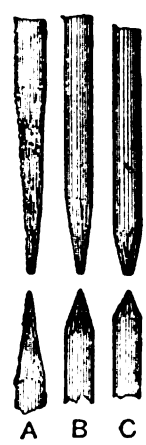

Fig. 6.

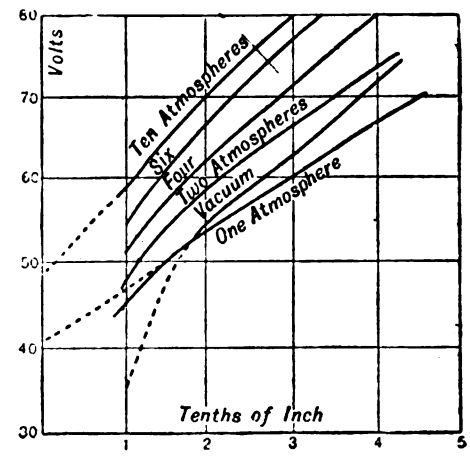

Fig. 7.

Incidentally I observed that the shape of the positive crater and of the negative peak is quite different, and differs in different gases. In coal-gas one finds that the hydrocarbon becomes deposited in the form of a mantle all round the crater, so that the negative peak penetrates up into a sort of chimney of deposited carbon. When one works at reduced pressures one begins to get into the vacuum-tube order of phenomena. The arc may be drawn out to a great length, and expands in size; but the luminosity of the tips of the carbons diminishes, and the phenomenon of the crater changes. Very little carbon is volatilised, and the E.M.F. required to sustain the discharge is lessened.

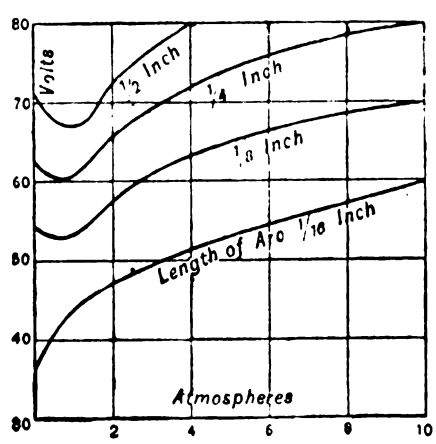

Fig. 8.

When, however, one increases the pressure, one meets with arc phenomena that are slightly different from those at atmospheric pressure. Here we have the justification of the view that the 39 volts is due to the work done in the vaporising of the carbon. So far as I know, much the most complete experiments yet made on this point are those made in America by Dr. Louis Duncan and some of his students. Figs. 7 and 8 embody in diagrammatic form the principal results of the researches.

Duncan caused the arc to be made in a vessel into which the air could be pumped, or from which it could be exhausted. Take, first, the case of the arc made at the ordinary pressure of one atmosphere. The sloping line marked "one atmosphere," in Fig. 7, here shows the connection between the volts and the length of the arc; the lengths in successive experiments being plotted out horizontally in one-tenths of an inch.

(To be continued.)

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NEW PARLIAMENTARY BILLS.

The Dover Corporation are applying in the ensuing session of Parliament for a provisional order authorising the construction of tramways in the borough, to be worked by animal, electrical, or other power. Bristol Tramways and Carriage Company, Limited, seek to obtain a provisional order to authorise the construction of tramways in the city and county of Bristol and urban district of Kingswood (Gloucestershire) and the use of electrical power upon the company's tramways. A provisional order is sought to authorise the incorporation of a company to construct street tramways in the Potteries district, to be worked by electrical power applied on the overhead system or otherwise. The Plymouth Corporation are seeking powers to construct additional tramways in the borough, and to work them by animal, electrical, or other power. Longton Corporation are applying for powers to construct tramways in the borough, to be worked by animal, electrical, or other power. The Great Western Electric Light and Power Company, Limited, intend to apply for a provisional order to authorise the supply of electricity for public and private purposes within the districts of St. George, Kingswood, Stapleton, and Warmley, and to enable the company to construct all necessary works, etc. King's Lynn Corporation seek power to construct works, lay mains, etc., for the production and supply of electricity within the borough. The Manchester Corporation are seeking powers to extend their area of electricity supply. The Keswick Electric Light Company, Limited, are applying for additional powers with regard to the supply of electricity within the township of Keswick and certain portions of the townships of St. John's, Castlerigg, Wythburn, Underskiddaw, and Above Derwent. The Altrincham Electric Supply, Limited, seek to obtain a provisional order to authorise the construction and equipment of works, laying of mains, etc., for the purpose of supplying electricity within the district of Ashton-on-Mersey and part of Bucklow.

THE EDISWAN FIREMEN'S DINNER.

The fourth annual dinner of the Ediswan Volunteer Fire Brigade took place at the Holborn Restaurant on Saturday last. Though nominally a firemen's dinner, it was practically a dinner of the firm, all departments of the works being represented. Major S. Flood Page presided, and there were also present Mr. H. C. Gover, Mr. C. M. Downie, Mr. C. F. Proctor, Mr. A. W. Torkington, Mr. Musgrave Heaphy, Mr. T. O. Belshaw, Mr. C. Undrell, Mr. W. Wake, Mr. A. W. Hill (captain of the brigade), Mr. F. Thompson (secretary), Mr. Millar and Mr. Dale (captains of neighbouring brigades), Mr. Hill, Mr. Woodley, Mr. Johnson, etc.—the total number present being about 80.

Mr. Gover, secretary of the company, in proposing "The Health of the Edison and Swan Company," congratulated the chairman on his recovery from his recent ill-health. Mr. Gover claimed that had it not been for the Ediswan Company and the action of their Board, the position of electric lighting in England would have been very different to what it was at present. Much of it, indeed, would have had no existence or would have been indefinitely postponed.

Major Flood Page, in replying, said that the names of Edison and Swan were known throughout the whole world, and there were not many places in the world where the Edison and Swan lamp was not also known. With reference to the position of the firm in regard to their competitors, he confessed that the incandescent gas light had certainly produced marvellous results. It was now 15 years since he was shown the incandescent light in Paris and sold gas shares in consequence. The same gentleman that showed him the incandescent lamp had just shown him also in Paris the Denayrouse lamp. They would see that light in England before long, and it put the arc lamp into the shade. It was a 5,000-c.p. lamp. However, whatever competition they might have to face the incandescent electric light would remain the light for domestic use, since it was beyond question the best for that purpose. The policy of the company was always to turn out the highest class work, and in regard to price it must be remembered that the cheapest was not the best. It was an open secret that fresh patents had been taken out by Mr. Swan. The company were selling more lamps now than during the protected period, and they would hold their own. In proposing "The Visitors," the Chairman referred to the high-voltage question, and said that so far as high voltage was concerned the lamp was the least part of the difficulty. It was simply a matter of study, and he hoped Mr. Woodley and their friends of the lamp department would be able to meet whatever reasonable demands were made. He would, however, like to know the views of fire insurance companies on the question. He doubted whether many installations ought to be subjected to the higher pressure without being properly inspected.

Mr. Musgrave Heaphy, who replied, said that the high-voltage question was being seriously considered, and he would not speak on it at present. He complimented the brigade on the smart turn out he had witnessed at Ponders End.

During the evening an exhibition of the kinetophone and various American fire-alarm apparatus was given by Mr. Johnson.

NEW CEILING-ROSES.

Our illustrations depict two new forms of ceiling-rose as made by Messrs. Baxendale and Co., of Miller-street, Manchester. One of the two main improvements is shown in Fig. 1 and the other in Fig. 2. The first consists in providing the rose with two "legs," or "feet," so that it may be placed straddlewise

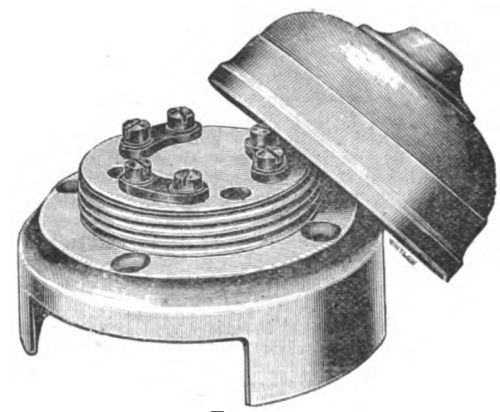

Fig. 1.

across the casing. There is thus no necessity to cut away anything except the casing cover, and no need for wood pattrasses or blocks. The rose is provided with four hold-down screw-holes, two in the centre line of the casing, and the others, one through each "leg," on each side of the casing. Obviously, ceiling-roses of this pattern can be much more quickly, neatly, and strongly fixed in position than the ordinary. The gap in the base is made to suit various thicknesses and sizes of casing, and they are provided with stop-ends, or non-throughway gaps, to give a finished appearance to ends of casing.

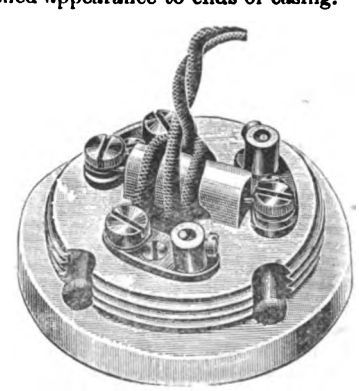

Fig. 2.

The second improvement consists (Fig. 2) in a combined fuse-shield and cord-grip. The base is formed with an arch-piece of porcelain. This arch-piece is pierced longitudinally, and through this is threaded the fuse, while the flexible cord may be twisted round it and all strain taken off the terminals. The arch-piece, or porcelain tube, affords a mechanical protection for the fuse, and, in the event of the fuse "going," prevents the metal from getting on to the cord. These "Beanco" ceiling-roses are made in various sizes, and with either or both of the improvements combined.

LEGAL INTELLIGENCE.

GASKELL AND ANOTHER v. GOSLING AND ANOTHER.

This case came before the Lord Chief Justice, without a jury, in the Queen's Bench Division. It was an action brought by the plaintiffs, a firm of manufacturers of electrical apparatus, carrying

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on business in Longport, in the Potteries, to recover £488. 9s. 3d, balance of account for goods sold and delivered to a person named Kelly, who was receiver for the debenture-holders in a London company, named Poole and White, who dealt in electrical apparatus. The defendants denied liability. Mr. H. Reed, Q.C. and Mr. Ansell were counsel for plaintiffs; Mr. Jelf, Q.C., and Mr. Hamilton for defendants.

Mr. Reed said that though the action appeared on the face of it as one simply for goods sold and delivered, yet it actually raised as important a question to the commercial public as could well be conceived—namely, whether trustees for debenture-holders who had appointed a receiver to carry on the business of a company which was in liquidation were themselves liable to pay for goods supplied to the receiver to enable him to carry on the business. The defendants were members of a London firm of bankers—Messrs Gosling and Sharpe—who were holders of some £3 000 worth of second debentures issued by the firm of Poole and White which had gone into liquidation. One often heard, said counsel of cases where persons supplied goods to companies, and, on applying for payment, were met by the debenture-holders' claims; but here there was something of a converse case for goods supplied to a receiver acting for debenture holders, and when payment was applied for the plaintiff was told that the goods were supplied to the company, and he must apply to the company for payment, it being well known that the company at the time was in liquidation and had no means of paying its debts. It appeared that in July, 1892, it being reported that the debenture-holders' securities were in danger, the defendants, as trustees for the debenture-holders, took possession of the property of White and Co., and appointed a receiver named Kelly, who conducted the business for the benefit of the debenture holders. Subsequently the company went into liquidation, but the liquidator could not touch the debenture-holders' property, and Kelly continued to carry on the business The plaintiffs supplied Kelly with £700 worth of goods, which sum was reduced by creditors to the amount now claimed; and counsel submitted that the debenture-holders were bound to pay for these goods which Kelly ordered for the purpose of enabling him to complete electrical apparatus in stock, so that he might dispose of the apparatus for the benefit of the debenture-holders.

The **Lord Chief Justice** said it was in his opinion a question of fact, though to be determined by considerations of law. He had to ask himself who were Kelly's principals. It was clear that after the winding-up order the company, *qud* company, ceased to have any actual existence, and it could not be doubted that the defendants were the real parties carrying on the business. He had to determine simply whether the plaintiffs had made out satisfactorily to his judgment that this was a case in which from December 25, 1893, to January 31, 1895 the present defendants were, in fact, undisclosed principals. He thought they had, and, accordingly, judgment must be for the full amount claimed, with costs. Execution was stayed pending an appeal.

JEFFRIES v. THE BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

This was an action in the Queen's Bench Division, before Mr Justice Hawkins and a common jury, for damages for personal injuries caused by the alleged negligence of the defendant company.

There appeared for the plaintiff Mr. Kemp, Q.C., and Mr. Cagney; and for the defendants, Mr Tindal Atkinson.

The **Plaintiff** (Mr. George Fish Jeffries) said that he was 73 years of age. He sold tea, champagne, and reversions, earning £2 or £3 a week. On January 8, 1895, he was in the City road, near the Artillery-ground, about seven in the evening. He tripped against a board covering a hole in the pavement, in which the defendant company were laying wires. He fell and became insensible. His eye and head were much damaged, and he had since been attended for his injuries. Next day he went to look at the place, and the boards had been bevelled off at the edges. He had since suffered much with his eyes, and from nose bleeding and giddiness He could no longer walk much, and had been unable to attend to his business. Up to the time of the accident he could walk 25 miles a day.

In cross-examination he said: Very likely he bought 20lb. of tea the week before the accident. He did not buy on commission but bought and retailed it. Perhaps it was 40lb. or 50lb He blended teas, 10 or 12 tons in the year, and made a profit of 6d. a pound. He had no list of customers, and he kept no books.

Witness, continuing, said that he tried to get a bed at several places after the accident, as he could not go home, but they would not take him in, as they thought he was a fighting-man, and he had to sleep in a common lodging-house. He did not tell a servant of the company just after the occurrence that he would give him a bottle of champagne if the company paid him 30s. compensation. Before the accident he carried glasses, but only as an ornament. They were a great set-off to a man, but afterwards he needed them for use, and very strong ones.

The jury ultimately awarded the plaintiff £50 damages.

CHELSEA ELECTRIC SUPPLY COMPANY.

In the actions of Sanden and Fowler against the above company counsel moved for a sequestration order for disobedience or breach of an injunction granted in respect of vibration caused by the defendants' machinery. After some discussion the motions were directed to stand over until to-day (Friday) in order that witnesses might be cross-examined in court.

HERCULITE AND ELECTRICAL MANUFACTURING COMPANY.

The *Financial Times* says that, on the petition of the Harburg and Vienna Indiarubber Company, a supervision order has been made in the voluntary winding up of the Herculite and Electrical Manufacturing Company, Limited.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Cleator Moor.—Tenders are invited for an electric light installation in the central stores of the Cleator Moor Co-operative Society. Particulars will be found in our advertisement columns.

Betanzos.—Tenders are invited by December 28 for the concession of the electric lighting for 25 years of the town of Betanzos, Spain. Conditions of La Direccion General de las Administraciones Locales, Madrid.

Ploesti.—The Municipality of Ploesti invites tenders by January 15 for the lighting by electricity of the 46 principal streets in the centre of the town. Conditions from La Mairie de Ploesti Roumania.

Saarbruck.—The Railway Telegraphs Inspection invite tenders by December 16 for the supply of 28 standard Morse apparatus. Conditions for one mark from Die Eisenbahn-Telegrapheninspection, Saarbrücken, Germany.

Manchester.—The Markets Committee desire tenders for the supply and erection of accumulators, columns, lamps, and wiring for the lighting of the Foreign Animals Wharf, Mode Wheel. Particulars will be found in our advertisement columns.

London, S.W.—The Secretary of State for India is prepared to receive tenders for caissons, air-compressing and electric light plant. Particulars are to be obtained from the Director-General of Stores, at the India Office, S.W., and tenders must be delivered by December 10.

Aussig.—The communal authorities propose to have built a seven-mile single-line tramway. The choice of system is left open. Contractors are invited to place themselves in communication with the Stadtrath, Aussig a.-d.-Elbe, Prussia. Tenders are to be in by January 31.

Leyton.—The Leyton Urban District Council invite tenders for electric lighting works as follows: Contract No. 1, central-station buildings; (3) gas-engines, travelling cranes, piping, etc.; (4) dynamos, switchboards etc.; (5) storage batteries; (6) five miles of mains, including laying Particulars will be found in our advertisement columns

Belfast.—Messrs. P. and F M'Glade invite tenders for supplying and fixing an electric plant for lighting their new premises, The International, corner of York-street and Donegall-street. Copies of specifications can be had, and plans inspected, on application to Messrs. George Coombe and Co., consulting engineers, Castle-lane-place, Belfast.

Charkow.—The Mayor of Charkow is prepared to receive tenders for the supply of steam and electrical engines for lighting, as well as apparatus and essential parts necessary for an installation of electric lighting of 6 000 incandescent lamps and 500 arc lamps. Illustrated catalogues and price lists, with lowest quotations, to be sent to the Mayor of Charkow, Russia.

Brussels.—The Ministère de la Guerre invites tenders by January 15 for (1) a heating installation, (2) electric lighting in the new military school to be constructed in the Avenue de la Renaissance, Brussels.—The Administration des Télégraphes require tenders by December 18 for the supply of various large lots of pine telegraph poles. Special cahier des charges No. 26 at the Brussels Bourse.

Transvaal.—The General Consul of the South African Republic asks tenders for the delivery of 5 000 k.g. 2 mm hard-drawn copper wire for the Government telegraphs Tenders which are not in American Hotel, Leidsche Plein at Amsterdam, before the 20th December, 1895 will not be taken into consideration. The conditions for the delivery can be furnished on demand by Brothers Belinfante, Paveljoensgracht, The Hague, at the price of 1s.

Leicester.—The Corporation invite tenders for the supply and delivery of the necessary cast-iron pipes and connections, from 2in. to 24in. in diameter, required during 12 months ending December 31, 1896 for the Gas and Electric Lighting Committee. Specification and form of tender to be obtained from Mr. Alfred Colson, M.I.C.E., engineer and manager, Millstone lane, Leicester. Tenders, addressed to Alderman Lennard, chairman and endorsed "Tender for Cast-Iron Pipes, etc.," are to be delivered by 11 a.m. on December 7.

London, N.—The Great Northern Railway Company invite tenders for the supply of new and the purchase of old stores for 12 months from January 1. A list of the contracts and separate forms of tender for each contract may be obtained upon application to Mr. Martin, the stores superintendent, Doncaster, by whom every information will be furnished, and the patterns of telegraph and electric lighting material will be exhibited at the telegraph stores, Retford. Tenders, addressed to the Stores Committee, marked on the outside with a description of the stores tendered for, must be sent to the company's offices, King's Cross, in the envelopes specially provided, so as to be received by 10 a.m. on December 7. Mr. William Latta, secretary, King's Cross Station, London, N.

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Durban (Natal).—The Corporation desire tenders for the supply, for delivery at Durban, and fixing at Durban, of steam and electrical plant for the lighting of the borough by electricity. The work will be executed under the direction of Mr. Fletcher (borough engineer) and Mr. Hadfield (electrical engineer) at Durban. The plant required includes high-speed engines, dynamos, cables, arc and other lamps, accumulators, etc. Specifications and plans can be obtained from Mr. W. H. Radford, C.E., Angel-row, Nottingham, consulting engineer to the Corporation, on deposit of £5. 5s., which will be returned on receipt of a bona fide tender. Sealed and endorsed tenders, in duplicate, must be delivered at the offices of Messrs. Webster, Steel, and Co., agents to the Durban Corporation, 5, East India-avenue, Leadenhall-street, London, E.C., by 28th inst.

RESULTS OF TENDERS.

Cordova.—The contract for the electric lighting of the town of Cordova, Spain, has been awarded to Señor Francisco Caballero, who quoted 78 pesetas per 10-c p. lamp per annum.

Tunbridge Wells.—Mr. F. Bruce, of Castle-road, Hastings, has secured the contract for installing the electric light throughout Messrs. Metcalf and Kirkpatrick's establishment in Wellington-place and also at the Kentish Hotel, Tunbridge Wells.

Brussels.—For supply to the Municipality of Brussels of pipes and apparatus for electrical distribution: MM. Denis, à Forest, 10·80fr. per 100 kilometres; Forges de Clabecq, 10 98, 10·98, 10·98, 12·48, 12·48, 12·48, 14·48, 14·48, 14·48, and 14·48 francs, in the order of the cahier des charges.

Eccles (Manchester).—The Town Council are recommended to accept the tender of the Manchester Edison-Swan Company, Limited, for the carrying out of the works of electric lighting according to specifications at the sum of £13,792, and subject to the Local Government Board granting to the Council borrowing power adequate for the execution of the whole scheme of electric lighting.

Clacton-on-Sea.—The following were the tenders for a complete installation of electric light at the convalescent home, for the Weekly Board of the Middlesex Hospital. Mr. Adrian Collins, A.M.I.C.E., 61, Old Broad-street, E.C., was the consulting engineer:

	Generating plant.	Wiring.
Siemens Bros., Limited	£3,153 0 0	£850 0 0
Mather and Platt	3.164 15 0	568 0 0
Johnson and Phillips	2,333 19 0	1,246 19 0
Crompton and Co., Limited (accepted)	2,370 17 0	697 0 0

Paris.—The adjudication for the supply to the municipal authorities of Paris of two 35 kilowatt dynamos capable of working at 110 or 160 volts has resulted as follows:

	Price.	Guaranteed efficiency, per cent.
Sautter, Harlé et Cie	12.500fr.	90
Maison Breguet	12,280fr.	87
Société Alsacienne	11,800fr.	90
Etablissements Cail	11,500fr.	90
L'Eclairage Electrique	9,500fr.	90
Compagnie Electro-mécanique	8 600fr.	91 at 110V. 89 at 160V.
Compagnie de Fives-Lille	7 685fr.	90
Société Gramme	7,390fr.	93
Postel-Vinay (accepted)	6,600fr.	90

BUSINESS NOTES.

Stafford.—The Town Council have decided to put up two arc lamps in the Market-square.

Eastern Telegraph Company.—The receipts for the month of November were £69,461, against £64,095 for the corresponding period of 1894.

Direct Spanish Telegraph Company.—For the month of November the receipts were £2,414, against £1,738 for the corresponding period of 1894.

Die Aktiengesellschaft fur elektrische Unternehmungen in Berlin (Union) has resolved to increase its capital from 15,000,000 marks to 30 000,000 marks.

Eastern Extension Telegraph Company.—For the month of November the receipts show an increase of £7,361 as compared with the corresponding period of 1894.

Bury St. Edmunds.—The Electric Lighting Committee have decided to entrust Mr. Medhurst with the preparation of a report on the electric lighting of Bury St. Edmunds.

Walthamstow.—The District Council have received letters from four firms with reference to a scheme for lighting the district by electricity, and have referred them to a committee.

Stockton.—The Stockton Town Council have agreed to appoint a committee to confer and visit other towns with respect to the provision of an electric lighting installation for the borough

Commercial Cable Company.—A quarterly dividend of 1¾ per cent., payable on January 2, has been declared. The transfer books will be closed on December 20 and reopened on January 3

Paper-Mill Lighting.—Messrs. Roger Dawson, Limited, of 53, Berners-street, London, W., have received instructions to instal nearly 500 lights at the London Paper Mills, Dartford, with plant.

Barnsley.—The Town Council have decided to fix the price of electric energy for motors at 3d. per unit.

Manchester.—The special meeting of the Town Council has been held to authorise the applications for a provisional order to extend the area of electrical supply and also for tramway extension.

Blackpool.—The Town Council have adopted a recommendation from a departmental committee to instruct the electrical engineer to prepare a scheme for the extension of the electric light works.

Bath.—The City Council have passed a recommendation of the Lighting Committee that the electricity company be asked to extend the hours of lighting half an hour each morning for three months.

The Telephone in East Anglia.—The National Telephone Company have notified their subscribers in Norwich, Ipswich, and Great Yarmouth of a reduced scale of rates for local communication in those towns.

Hamburgische Elektrizitatswerke.—This Company proposes to increase its capital by 6,000,000 marks and to acquire from the Elektrizitäts-Gesellschaft Schuckert the electricity works in the town of Altona.

Chelmsford.—In connection with the Arc Works fire, the subscription list started on behalf of the men temporarily thrown out of employment has been headed by 100 guineas from Messrs. Crompton and Co.

Royal Electric Company of Montreal.—Application has been made to the Stock Exchange Committee to allow the further issue of £34 000 sterling 4½ per cent. first mortgage debentures to be quoted in the official list.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended December 1 amounted to £1,020, as compared with £902 in the corresponding week of last year, being an increase of £118

Electric Lighting of Railway Carriages.—The Furness Railway Company have decided that, as an experiment, two of their passenger trains shall be fitted with Messrs. J. Stone and Co.'s system of electric lighting

Western Union Telegraph Company.—In its past financial year, the Western Union—one of the greatest of the American telegraph companies—added 11,859 miles to its wire lines, and 10 000 miles of that length added were of copper.

City of London Electric Lighting Company, Limited.—With reference to the issue of £100,000 5 per cent. debenture stock, applications for £522,335 debenture stock have been received, and letters of allotment and of regret have been posted.

Merthyr Tydfil.—A correspondent writes: "There is a possibility that Merthyr will in due season become as advanced as Abercanaid in the matter of electric lighting, notices having been given of an intended application to the Board of Trade for a provisional order."

Uddingston (Lanark).—"The gas in the village of Uddingston again gave out before seven o'clock on Tuesday night The evening schools, which are largely attended, had to be closed." So says the *Scotsman*. No wonder the residents are talking of introducing the electric light.

Waterloo (Liverpool).—The District Council have received a letter from the Liverpool District Lighting Company giving notice that they intended to apply for a provisional order to light Waterloo and Crosby with electricity. A committee was appointed to oppose the application.

Electrolytic Research Syndicate, Limited.—This Company has been registered with a capital of £1,000 in £1 shares. Object: to acquire any patents or inventions relating to the production of chrome and other metals by electrolysis or other kindred methods and to develop and work the same.

Allgemeine Elektrizitats-Gesellschaft.—We gave an abstract of the annual report of this Company in our issue of November 22, p. 601. We should add that the Electrical Company, Limited, of 122 and 124, Charing Cross-road, London, W.C., are the sole representatives for Great Britain and the Colonies of the German firm.

City and South London Railway.—The returns for the week ended December 1 were £987, compared with £928 for the corresponding period of 1894, being an increase of £59. The total receipts for the half-year 1895 were £19,549, compared with £19,576 for the corresponding period of 1894, being a decrease of £27.

Peterborough.—The engineer has produced before the City Council plans and descriptions of the proposed scheme of electric lighting and explained them He was instructed to prepare an estimate making provision for street lighting by electricity, and showing what would be the difference between the cost of electricity and gas.

Appointments Vacant.—The Vestry of St. Mary, Islington, require three electricians, one switch-room attendant, four engine drivers, four stokers, one foreman fitter, one timekeeper and storekeeper, two arc lamp trimmers, and one messenger in connection with the electric lighting station. Further particulars will be found in our advertisement columns.

Neston (Cheshire).—The electric light question continues to be the prevailing topic of conversation in the district, and the feeling in favour of adopting a well matured scheme appears to be growing as the various problems are threshed out. Some of the more important residents in the neighbouring districts have approached the promoters with a view to taking current from the proposed works if practicable.

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Sale of Electrical Apparatus.—The London Salvage Association, acting for the Thames Conservancy, intend to sell on December 9, at the London Commercial Salerooms, Mincing-lane, E.C., two Willans high-speed engines and a quantity of electric light fittings and stores, ex s.s. "Durham." Messrs. R Lyon and Co. are the auctioneers. Particulars will be found in our advertisement columns.

Dover.—At the last Town Council meeting it was remarked that several gas lamps, including the light in the Market square, were blown out by the gale which had disarranged the electric lighting. A letter from the electric light company, asking that the terms "dusk" and "dawn" should be substituted for "sunset" and "sunrise" in the agreement, was referred to the Lighting Committee for consideration.

Mevagissey Electric Lighting Company, Limited.—This Company has been registered with a capital of £1,500 in £1 shares. Object: to enter into an agreement with Veale and Co., Limited, for the establishment of an electrical installation (and the necessary machinery) in the town of Mevagissey, Cornwall, and to carry on the business of electrical engineers and suppliers of electricity (for all purposes) in all its branches

Birmingham.—Commercial prospects in Birmingham and South Staffordshire district are exceptionally bright. Enormous orders for axles and wheels, it is stated, as well as 10,000 iron telegraph poles, have been placed for the new Uganda railway, and a contract for £9,000 worth of iron and steel work has been signed with the Midland Railway. One Birmingham cycle firm, it is added, has advertised for no fewer than 1,200 extra hands.

Torquay.—Mr. F. J. Crocker has proposed that the Town Council should consider the question of acquiring and working the property of the Torquay Market Company, pointing out that the market buildings would be an admirable site for a central electric lighting station, and that the slaughter-house site at Upton would serve for the location of the proposed refuse destructor. The matter was referred to a committee of the whole Council.

Bangor (N.W.).—The *Observer and Express* of November 29 says that at Bangor the air is strongly charged with electricity, and the question of the suppression of gas by the electric light continues the main topic of discussion in the university city. "The resolution passed at the hastily-summoned meeting of ratepayers, held at the Penrhyn Hall on Friday night, was tantamount to a vote of censure upon the Town Council; but whether they regard it as such remains to be seen."

Bangor (Antrim)—With regard to the scheme for the improved lighting, it is now generally believed that the greater number of the ratepayers of the town are opposed to the large extension of the gasworks contemplated by the Commissioners, at a cost of between £5,000 and £6,000, in view of the recent improvements in electric lighting. It is believed that the electric lighting scheme now under the consideration of the Board will to a large extent take the place of the proposed gas extension.

Halifax.—An electric installation of 300 incandescent lights has been erected at Stones Mill by Mr. C. F. Fox, electric engineer, Halifax. Mr. Fox has also been entrusted with the electric lighting of Messrs. J. Crabtree and Sons' cotton mill, Salterhebble. The Trades and Labour Council are going to send a deputation to the Town Council asking them not to permit a private company to lay down a system of electric trams. If tramways were laid, it should be by the Town Council and under their control.

Buxton.—The Chairman of the Urban District Council said at the last meeting that they had received a letter from the Board of Trade in reference to the draft *re* the Electric Lighting Act. He did not know whether they had advanced enough to discuss that question. If left in the hands of the Electric Lighting Committee they could give the Council the cream of it in their report. This was agreed to, Councillor Cooper remarking that he was going to call a meeting of the committee early next week.

Dundee.—The Gas Committee of the Dundee Town Council have received an application for a supply of electric energy from a firm in Tindal's-wynd The application was granted, and the committee authorised the necessary agreement to be entered into. It was reported to the Gas Committee that coal was being supplied at the electrical station to the extent of about 40 tons a week without contract. The clerk was instructed to advertise for tenders for a supply of coal for the station until April 30.

Cork.—The minutes of the Electric Lighting Committee of the Corporation show that the town clerk was authorised to obtain additional expert advice as to the probable cost of lighting the city by electricity. The town clerk explained that he had arranged with the engineer of the electric light works in Dublin to furnish an estimate at the cost of 10 guineas. This had been done in order to fortify the Corporation in applying for a provisional order, as the estimate of Mr. Smith had been questioned in certain quarters.

Brierley Hill (Staffs.).—The Lighting Committee of the Urban Council have recommended that electrical engineers be engaged, at a fee of 30 guineas, to advise the Council as to the adoption of the electric light. Some members urged that the gas company should be approached as to a reduction of price and increase of illuminating power before any information was obtained as to the electric light. Ultimately the subject was adjourned for a month, and the report referred back to the Lighting Committee.

Shrewsbury.—A local paper says: "Our enterprising tradesman, Mr. L. Scholz, hairdresser, Pride-hill, has recently added another novelty to his establishment; besides having his premises illuminated by the electric light, he has had an apparatus fitted up by which the shafting from which the brushes are propelled is driven by electricity Anyone who has been operated upon under the new system cannot but recognise its superiority over the old hand power. The apparatus has been fitted up by Messrs. Lea and Son, electricians, of this town."

Edinburgh—The dome of the proposed new observatory on Calton Hill will be worked by an electric motor. The Town Council have decided to set up a new standing committee for the electric lighting, and it was remitted to the committee to consider and report as to what extensions should be made to the machinery and mains in view of the probable demand for next winter. Mr. Mackenzie explained that they had now wired on to their system 43,000 8 c.p. lamps, in addition to the street lamps. That, in seven months, was more than Prof. Kennedy expected them to have in three years.

Coventry.—The newly constructed electric tramways have been officially inspected on behalf of the Board of Trade by Major Cardew, who was accompanied by the Mayor (Alderman Loudon), Alderman Marriott (chairman of the General Works Committee), Alderman Worwood (vice-chairman General Works Committee), Councillor West, Mr Lewis Beard (town clerk), and Mr. E. J. Purnell (city surveyor), the tramways company being represented by Baron Turquoin and Mr. W. Sebastian Graff-Baker, directors. The system is the overhead conductor system, and the trial trips have proved very successful.

East Grinstead — The General Purposes Committee have reported to the Urban District Council that, having met Messrs. Lucas and Pike, electrical engineers, they cannot advise the Council themselves to undertake the installation of electric lighting, but recommend the Council to give an undertaking for 10 years to use electricity for street-lighting, providing the proposed company will undertake to supply arc lamps of 2,000 c.p, at a cost not exceeding that now paid for three ordinary street lamps, burning no less than the same number of hours, the whole arrangements to be subject to an agreement approved by the Council.

Copper.—The *Financial News* says that although the stocks of copper in England and France and afloat thereto are 4,652 tons smaller than they were at the end of October, the price of Chili bars on November 30 was exactly £2 lower than on October 31. The total supplies last month only came to 9,145 tons, while the deliveries amounted to 13,797 tons, and as consumption in the United States has more than kept pace with the increase in production, it is strange, the journal adds, that the fall in price should have taken place. At present the visible supply only amounts to 45,731 tons—figures which have had no parallel for the last seven years.

Gravesend.—The Town Council have received a letter from Messrs. L V. Riley and Co., stating that it was proposed to apply for a provisional order, and, if granted, they would be prepared to guarantee to supply electricity in Gravesend at a charge not exceeding 6d. per unit; to complete an installation equal to a supply of not less than 2 000 16-c p. incandescent lights within a year of the date of the order, and to enter into an agreement giving the Corporation the option of purchasing the installation at the end of seven years and within 14 years at a price equal to 10 per cent. advance on the capital outlay. The letter was referred to the Finance and Works Committees conjointly.

Aston (Birmingham).—The Highways Committee have reported to the Urban District Council that, as authorised, they had had the electrical appliances at the baths examined by Mr. Vaudrey, C.E., of Birmingham, who stated that the fittings were in a fair condition, and the committee stated that in view of Mr. Vaudrey's recommendations they had instructed the clerk to give Messrs. Fowler and Lancaster notice requiring them to put in new accumulators in accordance with their contract and, failing compliance therewith, they had requested the Baths Sub Committee to obtain tenders for the necessary renewal of the plant and alterations at a cost not exceeding £200 The report was adopted.

Lancaster.—Mr. Jackson, in moving the adoption of the minutes of the Lighting Committee at the last meeting of the Town Council, said there had been one or two important matters. They had decided to erect new lamps in different portions of the town, and these lamps were not only necessary but they would get some revenue from them They would have been glad to do more, but their funds would not allow them. They had proved this year the cost of electric light as compared with gas, and he might say that it had taken rather more than one-sixth of their revenue to light the portions of the town that were so excellently lighted by electricity. The minutes were confirmed.

Cheltenham.—The Town Council have received a letter from the directors of the gas company declining the suggestion of the Lighting Committee for a conference on the question of the sale of their undertaking, and stating that their determination was to oppose to the utmost the Corporation's proposal to purchase. Alderman Norman remarked that the number of 8-c.p electric light lamps for which applications had come in was 5,120 4,300 of which had already been wired, and the remainder of which it was hoped would be wired within the present week. He added that the success of the light had exceeded his anticipations, and the undertaking was now in a condition to bear all the expenses connected with it.

Kingswood (Bristol).—The Chairman of the Urban Council said at the last meeting that he did not know whether they had seen the announcement of the electric light company's intention to apply for a provisional order for supplying public and private electric lighting in the districts of Kingswood and St George. He would like to point out that if that provisional order were granted it would give the company authority to supply the

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electric light to private consumers throughout the district of Kingswood, as covered by the Urban Council. As the matter was one that interested them a good deal, he thought it would be as well to get legal advice thereon. The chairman's suggestion was eventually adopted.

Newcastle-on-Tyne.—At Wednesday's meeting of the Town Council Mr. Forster asked if anything had been done towards calling a statutory town's meeting for the consideration of the lease for the cable tramways. The Mayor said he thought it might be possible to hold such a meeting about the first week in January. Mr. Forster intimated that as the matter was causing a good deal of interest in the city he had decided to go to Bristol next week to see the different systems at work, and he would be glad if any gentleman would accompany him. Several special members were elected to the standing committees of the Corporation, and it was agreed to appoint a special committee to consider the desirability of the Corporation undertaking the provision of electricity.

Hendon (Middlesex).—The Works Committee of the Urban Council have reported the receipt of a letter from the secretary of the General Post Office intimating that if the Council were prepared to waive their stipulation that iron telegraph poles should be used for the extension of telegraphs to The Hyde, the Department were now in a position to provide the desired communication, the line to be constructed from Chapel path along Burroughs-lane and Edgware-road. Having regard to the great need for the proposed telegraphic communication, the committee recommended that, provided iron poles be used in the line of telegraph from Chapel-street to Edgware-road, the Council would waive the stipulation for their use in the remaining length. The recommendation was approved.

Prudential Assurance Company.—Although the plant for generating the current at this Company's London premises is still in excellent working order after 10 years' work the rapid increase of the Prudential Company's business has made it necessary for the Company to instruct Messrs Drake and Gorham to remodel the general apparatus throughout, substituting plant of a more compact nature. Owing to the results which have been attained by the use of slow-speed apparatus, Messrs. Drake and Gorham have decided to keep to this class of plant, but to dispense with all belt and gearing. The engines and dynamos, built on one shaft, will run at 85 revolutions per minute. The engines will be of Messrs. Marshall's horizontal type, and the dynamos are being built by Messrs. Crompton.

Grimsby.—Telephony in Grimsby seems to be in a bad way just now, according to a local writer: "Subscribers to the telephone seem to be in a suicidal state just now. No power that can be brought to bear upon the local managers of the company seems to affect those immovable pieces of responsibility—not even mild swearing along the wires. The sort of thing that goes on might be almost classed as tragic, for those who rent the instruments are at their wits' end to know what is to be done next. Threats have been used, gentle persuasion has been used, curses have been indulged in, love messages and sweet words have been sent to the fair voice at the exchange, everything in creation has been tried, but the telephone still hangs upon the wall to all intents and purposes a mockery—so say the unhappy subscribers."

Fareham (S. Hants).—Thus a local journal: "What will be done in regard to the Fareham electric lighting works? The judgment given in the Court of Queen's Bench means that the District Council must either pay the electric light company £3,800 damages for breach of contract or proceed to carry out the undertaking entered into by the defunct Local Board to take over the works, which undertaking was, after all, binding upon the Council. To the majority of the councillors, whose repudiation of the contract has brought about this condition of affairs, it is but a choice of evils. Some of them are already expressing an opinion that it would be cheaper in the long run to pay the £3,800 damages and leave the electric light alone. The matter is one in which it would be wise to consult the ratepayers, who will have to pay the piper in either case."

Hull.—The Electric Light Committee has been considering the possibility of extensions in connection with the Board of Trade's new regulations. The Corporation have already spent in Hull in mains nearly £19,000, and if the use of the new higher voltage lamps is not permitted by the Board of Trade, another sum equal to this will have to be expended very shortly in order to double the size of the mains to meet the requirements of new consumers, whilst if the Board permit the use of such lamps, double the quantity of lamps may be used without one farthing extra being spent on mains; and also all future extensions in the town will participate in similar savings, the amount of which in the future must be several thousands of pounds saved to the town. Twenty applications for the supply and extension of the light to consumers were also dealt with.

Bromley (Kent).—The Urban Council have received a letter from Messrs. Waterer and Dickins, declining, on behalf of the syndicate, to pay any portion of the enquiry fees as to the electric lighting, and asking for certain plans. The Chairman said, as he understood the letter, it meant that if the Council would make them a present of £300 they would do certain things in connection with the opening of the roads. The syndicate really asked that the provisional order be handed over to them to carry out, and this he thought objectionable. Mr. Davis thought there might be a competing set of ratepayers who might be aggrieved at the order powers being handed over to this syndicate. The Chairman said the better plan might be to ask the syndicate to nominate a deputation to meet the Electric Lighting Committee of the Council, and this was agreed to.

Ipswich.—The Town Council have considered a communication from the County of London and Brush Provincial Electric Lighting Company, Limited, Mr. Paris, the representative of the company, attending. The Mayor said the application from the company was that the Council would consent to a provisional order for powers to light the town of Ipswich, but neither the Council nor any committee appointed by the Council could possibly have had sufficient opportunity for considering the order or the advisability or inadvisability of consenting to the application. After some discussion, it was decided that a special committee should be appointed to make full enquiries as to the best course to be adopted for the electric lighting of Ipswich, and to report at an early date.

Llandudno.—At the annual meeting of the Llandudno Marine Drive Company a heated discussion took place on a recommendation in the report of the directors for the sale of their undertaking to an electric tram company for £12,500. The report added that the gross receipts for tolls during the year amounted to £663, and a dividend of 11s. per share was recommended. The chairman (Mr. T Williams) moved the adoption of the report. He said he was in favour of selling the drive, because he thought another company would make their famous drive more beneficial to the district. The report of the directors was carried by a large majority. As we intimated last week, the District Council have received several applications from syndicates to lay a system of trams in the town and district, and have decided to get the report of an expert as to lighting Llandudno by electricity.

York.—The City Council have adopted a resolution that the services of Prof. Kennedy, F.R.S., be retained as electrical engineer to the Corporation, the professor (1) to submit a comprehensive scheme for the lighting of the city, with estimates of costs, annual expenses, and probable income, to confer, when necessary, with the committee, and to support the scheme before the Local Government Board, for a fee of 100 guineas and out-of-pocket expenses; and (2) the professor to accept the appointment of engineer of the Corporation electric lighting undertaking, and to prepare detailed plans and specifications, and to supervise the execution of the work, for a commission of 5 per cent., and the fee of 100 guineas to merge in the same commission. Alderman Agar, in moving the adoption of the minutes, stated that the terms for the engagement of an electrical engineer had been accepted by Prof. Kennedy.

Gloucester.—Alderman Langley-Smith, referring to the scheme for electric lighting in the city, said at the last City Council meeting that he noticed that it was only proposed to take the electric light from the Cross as far as Hare-lane in Northgate-street; from the Cross to the Shire Hall in Westgate-street; and from the Cross down to Commercial-road in Southgate-street; and a short distance along Eastgate-street. He supposed that the Council in adopting such a course were actuated by good reasons, but it seemed to him that if such a schame was carried out it would be a waste of money. If they were going to have electric lighting at all, why not light the whole city? The Mayor said that before they got a provisional order they must state the minimum distance they were going to cover. They were naturally anxious to keep their responsibilities as small as possible until they had obtained the provisional order, when, if they thought it expedient, they could light the whole city.

London and Provincial Traction Company, Limited.—This Company has been registered, with a capital of £100,100, divided into £10,000 7 per cent. cumulative preference shares of £10 each and 100 ordinary shares of £1 each. Objects: to enter into or acquire by purchase or otherwise and carry out contracts or concessions or other grants in Great Britain or in any part of the world for constructing or purchasing and working of rail or tram roads, telegraphs, telephones, electric, hydraulic, or other works; and for the equipment of any such undertakings or works, with electric or other plant, stock, and apparatus; and generally to carry on business as general contractors in any part of the world. The signatories are: D. Parrish, 2, Copthall-buildings, E.C.; A. Parrish, 2, Copthall buildings, E C.; T. Wernher, 128, Bishopsgate street Within; T. R. Harris, 15, St. Swithin's-lane, E.C.; S. Neumann, Warnford court, E C.; L Hirsch, Warnford-court, E.C.; H. R. Batin, 6A, Austin Friars, E C.

Tunbridge Wells.—"Shopkeeper" writes to a local paper regarding the electric light: "I have just received the account for lighting my shop for quarter ending September 29, which comes to the sum of 4s 9d. May it ever be thus proportionately moderate!" It is stated that applications are coming in so rapidly for the electric light that the capacity of the central station is already nearly taxed to its utmost limits. It has, therefore been decided to at once proceed with the enlargement, ann the borough surveyor has been instructed to prepare plans for an additional building, and the orders for another boiler, engine, and dynamos have this week been given to be pushed forward with all speed. A good deal of misconception as to the new light is being removed, and it is now being generally understood that the electric light fittings are as cheap as, and in many cases considerably cheaper than, gas fittings, while the light itself is as cheap as gas, and by careful use proves more economical in actual cost. It is understood that the electric lighting of the Pantiles will be put in hand by the Town Council before long.

Wakefield.—Mr. G. W. Willocks, M.I.C.E, has held an enquiry at the Wakefield Town Hall relative to an application to the Local Government Board by the City Council for permission to borrow £25,000 for providing electric lighting. There was no opposition. Mr. Robert Hammond, of London, has been consulted by the City Council, and is to superintend the erection of the

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proposed works. The site is at Calder Vale, and they are to be carried on in connection or combination with the proposed sewage works. The high-tension current generated in the works is to be conveyed by cable in 5in. cast-iron culverts through Calder Vale-road, Kirkgate. Westgate, Silver-street, Northgate, etc. The estimated cost of the plant is £15,280. It is expected that when the works are completed the County Council will introduce the electric light into their new offices, the asylum authorities into that institution, the Board of Guardians into the proposed new infirmary at the workhouse, the School Board into the proposed new schools in Ings-road, and it is believed that the cathedral the theatre, and opera house, and other public buildings will use it.

Electrolytic Zinc Production.—At the statutory general meeting of the Smelting Company of Australia, the *Financial News* says, Mr. Alfred Fowler stated that the operations of the company would produce a revolution in the treatment of refractory ores. It is proposed to treat all classes of ore, but more particularly the refractory sulphide ores of which there is practically an inexhaustible quantity at the Broken Hill and other mines. Various processes will be used, including the electrolytic process for the recovery of zinc and the preparation of zinc oxide. With reference to the latter, before purchasing the patent rights Messrs. Siemens Bros., and Messrs. Siemens and Halske, of Berlin, had erected plant in Berlin to treat zinc ores and sulphide ores from Broken Hill on a commercial scale The Smelting Company of Australia, therefore, has purchased a process which has to some extent been demonstrated, and has only got to erect exactly similar appliances to those now in use in Berlin. The problem of producing metallic zinc from refractory ores is said to be solved by this invention, and the future of the company will therefore be watched with some interest

Lead-Powder Accumulators have recently been brought on the market by the Elektrizitäts-Gesellschaft Gelnhausen, m b. H. In these the active material of the electrodes consists of a mixture of mechanically-produced lead powder with neutral bodies of porous structure. As electrode supports patented strips of compressed lead are used. The admixture of the porous bodies has the result that the conversion of the lead peroxide into lead sulphate is quickly and uniformly effected throughout the whole material of the electrode, and therefore all deposits of the active material on the delivery of the current are brought into chemical work. It is claimed that through this more uniform conversion into lead sulphate, not only is crumbling of the active material prevented and the potential fall delayed, the efficiency being therefore increased, but also the accumulator is made indifferent to deep discharges and discharges at high intensities of current. For this reason the firm state that the lead-powder accumulator is particularly adapted for portable purposes in which deep discharges and discharges with considerably increased current strengths are frequently unavoidable. The firm is licensed to utilise the Faure patent.

Huddersfield —Mr. G. W. Willcocks, M.I.C.E., has held an enquiry at the Council-chamber, Huddersfield, into an application of the Corporation to the Local Government Board for permission to borrow £50,000 for the purpose of extending the system of electric lighting. The Town Clerk (Mr. F. C. Lloyd) stated that the Corporation had already borrowed £50,000 for the construction of works and supplying electricity in a prescribed area. With the exception of £3,000 which would complete works on hand, the whole of the money had been spent. There were at present 256 consumers and 36 applicants requiring supplies. The lights required by consumers and applicants amounted to 22 050 8 c p. lamps. There was a large demand for the electric light from districts outside the prescribed area, and it was estimated that altogether provision should be made for 50,000 8-c.p. lamps, to secure which the present application was being made. The Mayor (Alderman J. L. Walker) supported the application, and said he believed it would be found remunerative to supply the residential districts with the electric light, because of the night consumption. Mr. A. B. Mountain (the borough electrical engineer), Alderman Calvert, Mr. C. Adkinson, and Alderman J. J. Brook also gave evidence.

Eccles (Manchester).—The last minutes of the Town Hall and Electric Lighting Committee of the Town Council contained the following references to the electric lighting scheme and resolutions passed by the committee; "That in this Council's opinion it is not desirable to allow any company to come into the borough for the purpose of establishing electric lighting, and that the Council, therefore, be recommended to themselves proceed with the scheme rather than risk the possibility of power being granted to a company, as has occurred in other places where the Council have not taken that course"; and "that the Council be recommended to accept the tender of the Manchester Edison-Swan Company, Limited, for the carrying out of the works of electric lighting therein described, according to the specifications thereto annexed, at the sum of £13,792, and subject to the Local Government Board granting to the Council borrowing power adequate for the carrying out of the whole scheme of electric lighting." The committee also sent up a resolution recommending the Council to apply to the Local Government Board for power to borrow £20,000 for the purpose of carrying out the scheme At the termination of the other business the Council resolved itself into a General Purposes Committee in order to confer with the electrical engineer on the subject, and agreed to consider the suggestions and resolutions of the committee at a future meeting.

Bristol.—The Bristol Chamber of Commerce have discussed the National Telephone trunk line tolls. With reference to the joint memorial signed by the Cardiff, Newport, Swansea, Birmingham, and Bristol Chambers of Commerce, addressed to the National Telephone Company, Limited, it was reported that the general manager of that company had had an interview with the Newport Chamber and had explained that their trunk-line traffic had so largely increased that, in order to obviate the complaints of the public as to delay in getting through, the company had had to pay the Post Office charges. These were higher than their own, and had in turn to be charged to the public, and it was easy to see how the complaint arose. However, yielding to the representations of the chambers interested, Mr. Gaine was prepared to go back at once to the old charges, and abandon the use of the Post Office trunk line, if it was to be understood that the public would no longer complain of any delay arising from the crowded traffic, although Mr. Gaine thought that any change now would not be worth while, as the Government were to take over all the trunk-line business of the company on January 1. It was also reported that the Newport Chamber did not consider it worth while to press the matter further, but preferred to wait the incoming of the New Year. Upon the suggestion of the president, it was resolved to concur in the opinion of the Newport Chamber, and defer further action for the present.

Cardiff.—A deputation has attended from the Castle Arcade Company for the purpose of urging that the Corporation, through the Public Works and the Lighting Committees, should defray two thirds of the cost of repaving with stone the Arcade upon the laying of the electric light cables. It was pointed out that the company already paid rates and taxes in respect of their property, but did not get the same return as the ratepayers in St. Mary-street. The property was assessed to its full value, yet the company paid for the maintenance of the pavement and kept its own constable. Mr. Morgan said the company were anxious to get the electric light into the Arcade. That would necessitate a large amount of cutting up the existing cement pavement, and the expense of repair would therefore be heavy. They were anxious to relay the Arcade with stone, and the company would be able to utilise one-half of the Arcade while in the other half the work was in hand Councillor Morgan said it depended upon the amount of return the Corporation were likely to receive from the tenants of the Arcade whether they would be prepared to expend any public money there. It was resolved that the matter be laid by Councillor Morgan before the Lighting and Electrical Committee. The town clerk has reported to the Finance Committee that the Local Government Board had issued an order giving their consent to the Corporation borrowing £12 885 for the purposes of electric lighting, to be repaid with interest within 25 years.

Belfast.—On the report of the Electric Lighting Committee coming up in the Town Council, Councillor Masterson said reports were in circulation that the electrical machinery was not in a very good order—that, in fact, it was dangerous; and Councillor Woodside remarked that the electric plant was driven by gas-engines, and he did not think that was the most economical way. Councillor Wm. M'Cormick understood that no more current would be available when some orders which were in hand had been filled up. Alderman Pirrie, in reply to Councillor Masterson, said the machinery was recommended by Prof. Kennedy, who was one of the ablest electricians they had got. The contract was quite clear, that the engine was to be worked for 12 months, with a guarantee that at the end of the year, if not satisfactory, proper machinery should be put down. Any defects there were were mechanical, and they need not feel the least danger of their being short of light owing to the plant. As to the point raised by Councillor M'Cormick, he had to say that the committee were hampered and confined to a piece of ground hardly larger than that Council-chamber. They had not up to the present failed to supply any customer, and he hoped the committee would put before them such a scheme which would show that they were prepared, not only to keep the electric light before the public, but to make the Gas Committee give them, as they were now doing, better light. The report was carried.

Killarney.—Mr. J. Calvert, the auditor, has given his decision in reference to the payments made by the Commissioners under the heading of public lighting to the gas lessees and the Killarney Electric Lighting Company respectively. In the course of his judgment the auditor said: "Mr. Huggard, on behalf of the electric lighting company, made a very strong point in reference to the proceedings that Mr. Santry's tender should have been accepted by the act of affixing the Commissioners' seal, and further that only Mr. Santry's amendment was put to the meeting. I quite agree with Mr. Huggard that this would have been the correct thing to do; but I cannot agree with him in his contention that it renders the acceptance of Mr. Santry's tender null and void. A contract is an agreement between the parties that one of them shall do or perform some act or acts, or shall abstain from doing some act or acts. In this case Mr. Santry tendered or offered to do a certain thing—to light the town of Killarney for three years—and the very fact of the Commissioners accepting that tender, as I hold it was legally accepted, by the record of their proceedings at their meeting on September 18, 1893, binds them to Mr. Santry irrevocably for a period of three years, so long as he, on his part, carries out his contract. I therefore hold that Mr. Santry's tender was legally accepted, and that any further contract that was entered into by the Commissioners for lighting the town was illegal and unwarrantable, as a contract was already in existence."

Ogwen (N.W.).—The District Council have received a letter from the town clerk of Bangor stating that it was the intention of the Corporation to include in their license for the electric lighting scheme portions of Llandegai and Pentir, and in order to enable the Corporation to do so it was necessary that the Ogwen District Council should consent to the application. The Chairman, in reply to Lady Penrhyn, said that it would be no expense upon

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the parish. Mr. Richard Griffith, Cororion, proposed that the matter be adjourned for a month so as to give them time to consider it. The Chairman said that the town clerk of Bangor had enclosed the following formal resolution, which the District Council should adopt: "That the application to the Board of Trade by the mayor, aldermen, and burgesses of the borough of Bangor for a license under the Electric Lighting Acts of 1882 and 1888 having been considered and approved by the Ogwen Rural District Council, being the legal authority having jurisdiction within the parishes of Pentir and Llandegai, which form part of the proposed area of supply, the consent of the said Council is hereby given to the application." Mr. W. Roberts, Maesygroes, considered they would be stultifying themselves by giving such consent, as it would debar any other promoters from starting a scheme in the parishes, and perhaps by such competition the electric light would be supplied cheaper. The motion was then carried, and it was decided to communicate with Colonel Sackville West, the chief agent of the Penrhyn estate, as being one who would be largely interested in the matter, saying that the question had come before the Council, and inviting his observations thereon.

Hampstead (London).—The Lighting Committee of the Vestry have reported that it was not desirable at present to light High-street, Rosslyn-hill, and Haverstock-hill with either electric arc or incandescent gas lamps. The report was adopted. The same committee also reported that, pursuant to the authority delegated to them they had given instructions for a distributing main to be laid in Holly-hill, from Heath-street to The Grove, at an estimated cost of £56.—Approved. The Lighting Committee recommended that the necessary mains and transformers for the supply of electric current to provide consumers be laid down in the undermentioned roads, as shown on plans submitted—viz., Frognal, from Arkwright-road to Frognal House, at an estimated cost of £258; Fellows-road, £548; Willoughby-road, £143; Dennington-park-road, £128; Fairhazel-gardens Goldhurst-terrace to Greencroft gardens, £152; Chislett road, Priory-road (from Chislett-road to Canfield-gardens), Canfield-gardens (from Priory-road to Fairhazel-gardens), and Fairhazel gardens (from Canfield-gardens to Greencroft-gardens), £916; and Greencroft-gardens (from Fairhazel-gardens westward to Gleniffer). £128.—Adopted. The chief engineer was authorised to fix circulating water-pipes on the engines for the purpose of cooling the crank chambers, at an estimated cost (including a tank under steps in boiler-house, connections to water-pipes, suction ditto, and pumps) of £95; and he was also empowered to obtain house-connecting cable, T-joint boxes, and sundry articles required at the station, as provided for in the estimates for the year 1895 6, at an estimated cost of £98. 0s. 6d., and to obtain, and keep on stock, a spare arc armature. The Vestry Clerk said that he had received a letter from Mr. Robson, the Willesden surveyor, stating that the Willesden District Council were not at present prepared to consider the subject of lighting the High-road, Kilburn, by electricity. The letter was referred to the Lighting Committee.

Dublin.—Deputations from the Dublin United Tramways Company and the Southern District Tramways Company have been received by the Corporation. Dr. Carte read a statement as to the desires of the Dublin United Tramways Company. The time had now arrived when they should still further pursue the policy of extensions, and, as no doubt they were on the eve of a revolution in the system of traction by electric power replacing horses, the moment had come to propose for consideration a scheme of extension which should satisfy the needs of the city and suburbs of Dublin for some time to come. Dr. Carte then went through the proposed lines seriatim. Mr. Clifton Robinson then addressed the Council on the part of his company. They were an electrical company, and had control of a main line from which they proposed to conduct lines to four cardinal points in the city. They would do this without in any way interfering with their neighbours or duplicating their lines. They offered electrical lines unattended by the detriment and disadvantage of converting an existing horse line and the interruption of public traffic that would be thereby occasioned. Their lines would go through streets which had been hitherto unoccupied and neglected. They believed there was a great future in store for electricity as a motive power; but they did not want to force any particular method of traction on the citizens. They proposed to introduce the transfer ticket system, which had been in use for years in America and on the Continent of Europe. Alderman Meade moved that the letters received from the two companies and the statement read by Dr. Carte be referred to a committee of the whole house with power to confer with the representatives of the companies, the committee to report to the Council, and this was adopted Last Saturday a numerous company, including several members of the Corporation, assembled by invitation at the works of the electric tramway company, in Shelbourne-road, for the purpose of having a run to Kingstown on the electric tramway and of judging for themselves of the extent of its accommodation and of its adaptability for its purpose. The car was in charge of Mr. J. Clifton Robinson, C.E., managing director. The trip was a distinct success.

Sheffield.—In connection with the scheme of the London and Provincial Tramways Company the formalities consequent upon the application to Parliament for powers to take over the tramways in Sheffield and to extend the service into the neighbourhood have been complied with. Copies of the plans of the lines and sections have been deposited with the clerk of the peace for the West Riding, with the town clerk of Sheffield, the parish clerk of Sheffield, the town clerk of Rotherham, the parish clerk of Rotherham, the clerks of the Rawmarsh District Council and of the authorities in Handsworth, Ecclesfield, Greasborough, Tinsley, and Brinsworth. Copies were also lodged with the city surveyor, Mr. C. F. Wike. In London similar copies were deposited with the Board of Trade, at the Private Bill Office in the House of Commons, and in the parliamentary offices. Since the question of traction for tramways has been under discussion in the *Sheffield Telegraph*, the attention of one of the representatives of that paper has been drawn to a system of electrical propulsion patented by Mr. W. Aldred, of Brightside Bank, Sheffield. The fundamental idea of the system is that of the third rail, but it is modified by the substitution for the live rail of contact points, upon which a bar brush, suspended beneath the car, acts for the completion of the electrical circuit, and the production of the consequential motion. The abridgment of the patent gives this brief description of the system: "The two rails, one of which is electrically bonded to form a continuous rail, and the other of which has its sections insulated from each other, are used in combination with a central rail insulated in sections for the purpose of transmitting the current from the dynamo to the car. For every section there is a switch which, when closed, connects the mains from the dynamo to the rail from which current is taken by the car. The switch is closed by means of an electro-magnet excited from a battery carried on the car, the battery being connected to the electromagnet of each switch in succession through the centre rail and one of the side rails" Mr. Aldred exhibited to the representative a number of documents in connection with his patent, including a complete provisional specification. It is numbered 5,391, of 1894, the date of the application was March 15, 1894 the complete specification was left on December 17, 1894, and was accepted on April 13, 1895. He also called the attention of the reporter to two recent issues of the *Electrical Engineer*, containing an account of the Westinghouse underground system for electric traction. This system, Mr. Aldred said, was identical with his in its essentials.

The South Staffordshire Tramways—Mr. W. Somers S. Schuster, chairman of the South Staffordshire Tramways Company, Limited, has addressed the following letter to the *Birmingham Daily Post*: "Sir,—Up to the present time the attacks upon the South Staffordshire Tramways Company which have appeared in the columns of certain papers circulating in Birmingham and its suburbs have been anonymous, and have been therefore disregarded by the Board, although in various instances the name of the contributor and his real objects were well known to them. Now, however, a letter has appeared signed by Messrs. Duignan and Elliott, and addressed to the various local authorities, the object of which is apparently to secure the refusal of the renewal of the company's steam license, a refusal which would have a prejudicial effect upon the prospects of the company. It would be interesting to know the names of the 'people' who, according to Messrs. Duignan and Elliott, are anxious to come forward and put down unlimited funds, not only to equip the lines, but to pay all the liabilities of the tramway company. Messrs Duignan and Elliott have never forwarded to the Board any such proposal. The directors have only one object in view—viz, to do the best they can for their proprietary and the travelling public. One thing, however, I do desire to make clear, and that is that a refusal of the steam license, so far from forcing the hands of the directors, will only have the effect of complicating matters generally, of further damaging the credit of the tramway company, of turning out of work a large number of hands at a season of the year when bread is most needed, of causing a vast and needless amount of inconvenience to the travelling public by stoppage of the cars; and those who have considered the question from an engineering point of view know that it would be quite unreasonable to commence work of the character required at this season of the year. As the safety of our engines has been called into question in previous letters, I desire to take this opportunity of stating that, so far from their being in any way in a dangerous condition, those portions of the boiler which showed signs of wear have recently been renewed at considerable expense, and are certified as safe by the insurance company at full pressure. It is also gratifying to the directors to be able to state that since the appointment of their new manager the traffic receipts have increased, and the expenditure decreased, so that the general prospects of the line are daily improving." The Stoke Town Council have received a letter from the Board of Trade enclosing a copy of a communication which the Board had received from Mr. H. C. Godfray, solicitor, and stating that in the circumstances mentioned the Board had decided to consent to the use of steam power for a further period of six months. The Highways Committee, having read the joint report of the surveyors of Burslem, Fenton, and Stoke, reported that they were of opinion that the system of overhead traction proposed by the North Staffordshire Tramways Company was the best means of traction which could be adopted at present in this borough, but before giving formal consent thereto recommended that the town clerk be instructed to put himself into communication with the other authorities with a view to a combined course of action being taken, and that the question of the settlement of the terms of the proposed agreement with the tramways company stand over. This was agreed to, and a sub-committee appointed.

PROVISIONAL PATENTS, 1895.

NOVEMBER 25.

22505. **Active material for electric accumulators.** Fritz Dannert, Hermann Windolff, and Johannes Zacharias, 40, Chancery-lane, London. (Complete specification.)

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22480. **Improvements in dynamo-electric machines.** Henry Chitty, Hogarth Works, Chiswick, London.

22506. **Electric accumulator.** Fritz Dannert, Hermann Windolff, and Johannes Zacharias, 40, Chancery-lane, London. (Complete specification.)

22511. **Improvements in the production of bulbs for incandescent lamps.** Otto Max Constantin Heyl, 37, Chancery-lane, London.

22519 **Improvements in or connected with electric railways or electric transport.** Frederick Carleton Esmond, Norfolk House, Norfolk-street, London. (Date applied for under Patents, etc., Act, 1883. Sec. 103, April 26, 1895, being date of application in United States.)

NOVEMBER 26.

22543. **An improved carbon-holder for electric arc lamps and projectors.** George Wilson, Bryntirion, Glandare-road, Aberdare.

22569. **Improvements in or connected with electric bell-pushes.** James Withers Creasey and Thomas William Breach, 23, Coleman-street, London.

22574. **Improvements in the manufacture of insulating compositions for electrical purposes.** Charles James Grist, 55, Chancery-lane, London.

22586. **Improvements in single-phase alternate-current motors.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

22600. **Improvements in and relating to a system of telegraphic communication.** Isidor Kitsée, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

NOVEMBER 27.

22660. **Apparatus to protect against danger from overhead electric wires.** William Thomson (Baron Kelvin), 154, St. Vincent-street, Glasgow.

22661. **Improvements in apparatus for indicating and recording electric supply.** William Thomson (Baron Kelvin), 154, St. Vincent street, Glasgow.

22679. **Improvements in the construction of electric light fittings.** George Wadely, 19, Southampton-buildings, Chancery-lane, London.

22686. **Improved automatic electromagnetic interrupter for protecting electrical installations.** Charles Denton Abel, 28, Southampton-buildings, Chancery-lane, London. (Compagnie pour la Fabrication des Compteurs et Materiel d'Usines à Gaz, France.

22696. **Improvements in alternating-current arc lamps.** William Phillips Thompson, 6, Lord-street, Liverpool. (Wilhelm Mathiesen, Germany). (Complete specification.)

22717. **Improvements in telephonic apparatus.** Maxymilian Kotyra and Charles Milde, 45, Southampton-buildings, Chancery-lane, London.

NOVEMBER 28.

20925A. **Improvements in or relating to incandescent electric lamps.** Edward Burnet, 6, Lord-street, Liverpool. (Date claimed under Patents Rule 19, November 5, 1895.)

22732. **Improvements in a process and apparatus for the electrolytic production of metallic zinc from ores of zinc, and metallic zinc and metallic copper from zinc ores containing copper, and the production of oxygen gas in the cases specified.** Charles Anthony Burghardt and Gilbert Rigg, 35, Fountain-street, Manchester.

22736. **Improvements in electrical separators.** Silvanus Phillips Thompson and Miles Walker, Morland, Chislett road, West Hampstead, London.

22783. **An improved attachment for telephone receivers.** John Danaher Greene and Benjamin Warne-Browne, 2, Newcastle-street, Strand, London.

22793. **Improvements in and relating to electric vapour engines for vehicle and launch propulsion in particular.** Walter Rowbotham, 52, Wheeley's-road, Edgbaston, Birmingham.

NOVEMBER 29.

22846. **Improvements in and connected with automatically-operated electrical switches.** Frederick George Robinson, 10, St. George's-crescent, Liverpool.

22860. **Telephone communicating system for expediting messages.** Peter Ferguson, Fish Mart, North Hamilton-street, Kilmarnock.

22864. **Improvements in or relating to telegraphic receivers, especially applicable for submarine telegraphy.** Alfred Piedfort, 323, High Holborn, London.

22866. **Improvements in the extraction of copper from its ores by electrolysis.** Alfred Francis Bilderbeck Gomess, 9, Warwick-court, Gray's-inn, London.

22898. **Improvements in the manufacture of electrical fuse-boards and other like articles.** Richard Thomas Grocott, 18, Southampton-buildings, Chancery-lane, London.

22899. **Improvements in and connected with secondary batteries.** John Ebenezer Bousfield (of the firm of G. F. Redfern and Co.), 4, South-street, Finsbury, London. (G. Dorville and Co., France).

NOVEMBER 30.

22936. **Improvements in and connected with electrical commutators and collector rings and collectors therefor.** Thomas Frederick John Truss, 10, St. George's-crescent, Liverpool.

22939. **Improvements in electrical sounding apparatus.** Francis Gwyn Griffith, 22, Southampton-buildings, Chancery-lane, London.

22985. **A contact device for the transmission of electric current.** Carl Bremer, 31, Southampton-buildings, Chancery-lane, London. (Complete specification.)

22987. **An improved electrical lamp and battery, especially applicable for use in bedrooms, but applicable for various other purposes.** Mary Margaret Harris and Gerald Guthbert, 16, Lollard-street, Lambeth, London.

SPECIFICATIONS PUBLISHED.

1882.

224. **Electric lighting etc.** Lake. (Williams.) (Second edition.)

1892.

5652. **Conduits.** Lake. (Thomson-Houston International Electric Company.) (Second edition.)

1894.

15192. **Electric, etc., railways.** Sayers.

21489. **Electrical apparatus for working railways.** Deming.

22866. **Telegraph instrument.** Morriss.

23529. **Electric switches.** Lyon and Bevis.

23825. **Arc lamps.** Brockie.

23854. **Electrical distribution.** Wood.

24907. **Arc lamps.** Blackburn and Fairall.

1895.

298 **Electric vehicles.** Claret and Vuilleumier.

351. **Arc lamps.** Gwynne and Kennedy.

523. **Lightning arresters.** Belfield. (Westinghouse Electric and Manufacturing Company.)

1714. **Electric glow lamps.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

1717. **Electric accumulators.** Pirsch.

2650. **Electric bells or gongs.** Quincey.

3003. **Regulating electric motors.** Thompson. (Lauhoffer and others.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6¼
Brush Company, Ordinary	3	1⅞-1⅞
—— Non. Cum., 6 per cent. Pref.	2	1⅞-2⅛
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5⅛-5⅜
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6⅞-7⅛
—— 4½ per cent. Debentures	100	115-118
City of London, Ordinary	10	13-13¾
—— 6 per cent. Cumulative Pref.	10	15⅞-16⅛
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	130-132
—— 5 per cent. Pref. Shares	10	14⅞-15⅛
County of London and Brush Provincial Co., Ordinary	10	8¼-9⅛
—— 6 per cent. Cum. Pref.	6	8¼-9
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2⅛
Edison and Swan United Ordinary	3	1⅞-2⅛
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅝-¾
—— 7 per cent. Cumulative Pref.	2	2-2⅛
Elmore's Copper Depositing	2	1-1⅛
Elmore's Wire Company	2	⅝-¾
Fowler-Waring Cables	5	⅞-1
W. T. Henley's Telegraph Works, Ordinary	10	13⅛-14⅛
—— 7 per cent. Preference	10	15⅛-16⅛
—— 4½ per cent. Debentures	100	108-111
House-to-House Company, Ordinary	5	4⅛-4⅜
—— 7 per cent. Preference	5	8-8⅛
India Rubber and Gutta Percha Works	10	18-19
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge Ordinary	5	7⅛-8⅛
—— 6 per cent. Pref.	5	7-7⅞
Liverpool Electric Supply, Ordinary	5	7⅞-8⅛
Liverpool Overhead Railway	10	11⅛-11⅝
—— 5 per cent. Pref.	10	15⅛-15⅞
—— 4 per cent. Mortgage Debentures of £100	100	113-115
London Electric Supply	5	⅞-1
Metropolitan Electric Supply	10	10⅛-11⅛
—— 4½ per cent. First Mortgage Debenture Stock	100	117-120
National Telephone, Ordinary	5	6-6⅛
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15⅛-16⅛
—— 5 per cent. Non. Cum. Third Pref.	5	6⅛-6⅜
—— 3½ per cent. Deb. Stock	100	105-107
Notting Hill Company	10	8¼-9
Oriental, Limited, £1 shares	1	1-1⅛xd
—— £5 Shares	5	7⅞-8⅛xd
—— £4½ shares	4½	6⅛-6⅝xd
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-105
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8-8⅛
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	39-41
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4⅛-5
Westminster Electric Supply, Ordinary	5	8-8⅛
Yorkshire House-to-House	5	6⅞-7⅛

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NOTES.

The New German Safety Rules will shortly be published. The commission entrusted with the task of drawing up the measures has completed a portion of its labours.

The Verband deutscher Elektrotechniker discussed at its meeting on December 7, in Berlin, the question of word-marks in connection with the German Merchandise Marks Act.

Royal Scottish Society of Arts.—At the last meeting of this society, Prof. Armstrong, president, occupying the chair, a communication was read by Lord Kingsburgh on "Electricity in the Household."

A New Cable Across the Yangtze.—It is stated that the Chinese Telegraph Administration has recently laid a cable across the Yangtze to Tsungming, and that telegraphic communication with that important island will shortly be opened to the public.

Electric Cooking and Heating.—At the last meeting of the Hanover Elektrotechnischer Verein, Herr Ingenieur Dr. Hartmann, of Berlin, read a paper on "The Application of the Electric Current to Cooking and Heating Purposes in the Household and in Industry Generally."

Electric Fans for the Navy.—The Admiralty have, it is stated, decided to experiment with electric fans, which will be fitted to the cruiser "Pearl" at Devonport. If the experiment prove satisfactory, it is understood that the "Phœbe" and "Philomel," on the Cape station, will be similarly fitted.

Acetylene.—At the last meeting of the Liverpool section of the Society of Chemical Industry, at University College, Dr. Campbell Brown illustrated the illuminating properties of acetylene, and pointed out various difficulties in the way of using the gas as an illuminating agent; and Dr. Kohn repeated an experiment illustrating some of the causes of the illuminating power of hydro-carbon vapours.

Electric Fog Signalling.—A party of gentlemen, including Captains Wilson and Parke, of the Board of Trade, and Lieut.-Colonel Martindale, has inspected on board the steamer "Dungeness" at the St. Katherine's Dock, London, the improved form of an arrangement designed by Mr. F. H. Berry for automatically giving the bell and whistle signals required of a ship in a fog. The apparatus, by means of electricity, not only sounds the bell or blows the whistle at the necessary intervals, but also leaves a permanent record in red and black inks on a strip of paper of the times at which these operations were performed. Both the frequency and the duration of the signals can be easily regulated.

The Pacific Cable Scheme.—It is announced that the representatives of New South Wales, Victoria, and Queensland, assembled in Sydney, have decided to appoint delegates to the Pacific Cable Conference, probably the Hon. Duncan Gillies and Sir Saul Samuel, the Agents-General in London of Victoria and New South Wales. New Zealand, it appears, was not represented at the meeting, but expressed her assent. It is expected that South Australia and Western Australia will acquiesce in the arrangement. It is stated that the Australian representatives now in Sydney are divided on the question whether the proposed Pacific cable shall start from Queensland or New Zealand.

An Unusual Central-Station Accident.—The *Electrical World* says that at 7 a.m. on the morning of Friday, November 14, an 8in. steam-main burst in the Elizabeth-street Brush Station, New York City, filling the whole station with scalding steam before it could be shut off, which was not until 15 minutes later. The boiler pressure was 110lb., but fortunately the plant had just shut down and the fires were banked. Even in the brief interval during which the steam was escaping havoc was played with the belts, which were scalded so badly as to practically ruin them, only a few which were completely saturated with oil escaping. The leather was in such a brittle condition that it could be fractured by a blow, and all the glued joints came apart or had become so treacherous that it was unsafe to run with them.

Possible Cause of Flat Wheels.—A number of large electric traction companies find that the renewal of flat wheels involves considerable expense. Among the causes which lead to the shortening of the life of the wheel may be the severe arcing that not infrequently occurs between the wheel and the rails. The resulting heating tends to anneal the chilled rim, with the consequence that flat surfaces are produced when the wheel skids. It has been suggested that as a possible remedy for this evil a steel brush pressing on the head of the rail might be used to reinforce the wheel contact. If such a device could be made practicable it would serve a double purpose; it would keep the contact surface clean and reduce the arcing at the wheels by taking a considerable proportion of the current, and at the same time a saving in power would be effected.

Railway Telegraph Routes.—An important judgment has been delivered in the Supreme Court of the United States by Mr. Justice Harlan, who has decided that the contracts and agreements between the Union Pacific Railway Company and the Western Union Telegraph Company, by which the latter was given the sole right to maintain its telegraph lines on the right-of-way of the railroad company, are null and void, and cannot be enforced. The learned judge said that any telegraph company which accepted the terms of the Act of 1866 had the right to place its poles on any postal route of the United States, provided it did not interfere with the railroad company in the operation of its line. The Union Pacific Company, under the terms of the decision, must, he averred, undertake the management of its own telegraph line along the route of its railroad.

Electrical Nomenclature.—Mr. Frederick Walker, C.E., F.S.P.A., read a paper before the Society of Patent Agents at the general meeting of that body on Wednesday on "Electrical Nomenclature and the Classification of Electrical Patents." The main object of the paper was to point out the extension of the general terms used in electrical science, and protest against the classification of the printed specifications at the Patent Office, which were, it was stated, based upon obsolete systems, and rendered what should be a simple search a formidable and harassing undertaking Mr. Horn, F.S.P.A., after the discussion, moved: "That there should be special divisions of the subject-matter indices relating to inventions, and more particularly to electrical inventions, similar to what prevails in the United States and Germany." The paper and this resolution which was carried, form together the subject of a memorial to the Board of Trade.

Accumulators v. Resistance Coils.—M. Albert Nodon, writing in *L'Electricien* of November 30, remarks that the introduction of resistance coils into a circuit must always produce a waste of energy, and in some cases of arc lighting the proportion lost is a serious one. He suggests, therefore, that where it is desired to lower the potential, accumulators should be used and the energy recovered from them. For instance, with two arcs in series on a 110-volt line there would be 30 volts with a six or eight-ampere current available for charging the accumulator.

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In the case of an alternating current, he suggests that a rotary transformer should be used, and states that this has been done experimentally at Havre with success. It is, however, added that the continual attention that must be given to accumulators would probably prevent their adoption by most people, and that there are, unfortunately, numerous practical inconveniences in the way of their use. Probably, if this were not the case, M. Nodon would not have had an occasion for the suggestions he makes in his article in our contemporary.

The Polarisation of the Light of Incandescent Bodies.—The polarisation of the light emitted by incandescent bodies has not yet been fully investigated. Arago, indeed, made some experiments on incandescent iron, platinum, and glass; but these were only qualitative, and did not extend to liquids. Mr. R. A. Millikan publishes, in the *Physical Review*, an account of some careful tests of light emitted by glowing solids and liquids, with a view to discovering the laws of its polarisation. This phenomenon is exhibited strongly by incandescent platinum, silver, and gold, and by molten iron and bronze. A somewhat feebler polarisation is shown by copper, brass, lead, zinc, and solid iron. The most significant result is that polarisation is minimum with rays emitted normally to the surface, and maximum at a grazing emission. This indicates that the vibrations take place in a plane at right angles to the emitting surface. To show the phenomenon at its best a smooth surface is essential. Glass and porcelain also emit polarised light, but to a less amount. Fluorescent bodies do the same; so that evidently a high temperature is not necessary.

Accumulator Patent Disputes in Germany.—The action which the Akkumulatorenfabrik Aktiengesellschaft in Hagen brought against the Neue Berliner Elektricitätswerke und Akkumulatorenfabrik Aktiengesellschaft (vormals Hirschwald, Schäfer, and Heinemann) for infringement of patent has resulted, it is stated, in a Berlin court deciding that the accumulators of the latter firm fall under the Faure patent, and that the Hagen Company is justified in prohibiting the firm from producing further accumulators of the kind in dispute. The Berlin firm has appealed against the decision, alleging that it can only apply to its predecessors, Herren Hirschwald, Schäfer, and Heinemann. In this connection it is interesting to note that under the title of Internationale Elektricitäts und Akkumulatoren-Gesellschaft, Berlin, a company has been formed, with a capital of 4,200,000 marks, which proposes to exploit 10 foreign accumulator patents, besides the patents of Herren Hirschwald, Schäfer, and Heinemann, according to which, as binding medium of the active material, pure glycerine mixed with butyric acid is used.

Electro-Pneumatic Continuous Brakes.—M. G. Lesourd has described in a paper read before the Socié é des Ingénieurs Civils de France on November 22 the Chapsal electro-pneumatic brake. With continuous brakes worked on either the pressure or vacuum system, when the train is very long, the distribution of pressure will take some time to effect itself, and the braking action will not be simultaneous all along the train. Various devices have been adopted to obviate this, with more or less success. That of M. Chapsal is an electrical apparatus. Two wires for putting on and taking off the brakes run the whole length of the train. These work valves under each carriage, and in the case where the system is applied to the Westinghouse brake the upper part of the triple valve is modified. M. Lesourd illustrated his description by models worked with a cylinder of compressed carbonic acid, but the *Bulletin* gives no detailed description of the apparatus. It was claimed, however, that it was exceedingly efficient, and at the close of his demonstration M. Lesourd was complimented by the president. The Chapsal apparatus, with some modifications, can be applied at comparatively small expense to almost any existing system of continuous brakes.

Storage Batteries v. Gas-Engines.—The communication of Mr. Nelson W. Perry, presented before the last meeting of the American Institute of Electrical Engineers (the New York *Electrical Age* of November 30 says), states in plain terms the author's opinion regarding the use of storage batteries for the purpose of relieving electrical systems of the strain due to sudden and violent fluctuations of load. Mr. Perry prefers the gas-engine to accomplish the desired results where the question of economy is the dominant one. Even where it is necessary to use gas from the street mains, he maintains, it would be more economical to use a gas-engine to take the peak off the load than to instal a storage battery plant for the same purpose. The gas-engine industry in the United States, according to Mr. Perry, is managed in a very incompetent and unintelligent manner. He claims that American manufacturers do not really know what their own engines are capable of doing, and so unsatisfactory is the condition of things there, with respect to these engines, that "recent large orders for gas-engines have gone abroad, where the business is conducted on business principles." Our contemporary considers that this is a serious charge to make, and that if there is the slightest semblance of truth in it, American gas-engine interests should be alive to the situation.

Visible Radiation and Temperature.—A new determination of the lowest temperature at which a hot body becomes visible is published by Signor Pettinelli, in the *Nuovo Cimento*. He heated a cast-iron cylinder 30cm. long and 14cm. broad, in a wrought-iron jacket over a Bunsen burner to a temperature of 460deg. C., as indicated by an air thermometer, and then observed its flat end in a dark room from a point 60cm. above it. When it had cooled to about 415deg. the red heat vanished and gave way to an indefinite hazy glow. This glow completely disappeared at 404deg., and repeated observations gave an error of only 3deg. High emissive substances, such as the mantles made by Auer and others for incandescent gas lighting, became visible at the same temperature, but reflecting surfaces had to be heated 20deg. higher before they appeared to the eye, and glass still more. These low-temperature rays were found to traverse glass and water like ordinary light rays, but they suffer a comparatively greater absorption. Different eyes differ slightly in their capacity for seeing them, the maximum divergence being about 6deg. But the extent of surface must be the same. Signor Pettinelli found that if he screened off all but $\frac{1}{10}$th of the surface, the body had to be heated 6deg. higher than before to become visible.

The Incandescent Lamp Question.—The *Elektrotechnische Zeitschrift* of December 5 contains the full report of the commission which was appointed by the Union of Representatives of Electricity Works in Germany (Vereinigung der Vertreter von Elektrizitätswerken) to investigate the incandescent lamp question. The report is not very satisfactory from several points of view. It states that "the complaints of consumers that the incandescent lamps are bad—good for nothing—are justified." As the causes of this regrettable condition of things it gives: Imperfect sorting, false marking, little economy, and too short life of the lamps. In 70 lamps supplied by eight makers, which were given as 16 standard candle-power, and whose rate of consumption should have

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been 3·25-3·50 watts per candle-power, the illuminating power fluctuated between 7·82 c.p. and 22·85 c.p. and the rate of consumption between 2·8 and 6·3 watts per candle-power. One of the very first German firms supplied 20 incandescents specially for the investigations. In these 20 the illuminating power fluctuated between 10·21 c.p. and 21·6 c.p., while the consumption in watts averaged 4·1 per candle-power. In 10 16-c.p. 3·5-watt lamps from another first-class firm the illuminating power decreased in the course of 48 hours' burning by from 40 to 60 per cent., while the consumption in watts per candle-power rose on the average to 5·6.

The Hatch Storage Battery.—An exhibition of the Hatch storage battery recently took place in Philadelphia, and the results are said by the *Electric Railway Gazette* to have been entirely satisfactory to the members of the exploiting company. It is stated that the batteries have been successfully used for street car propulsion, and that a car equipped with them has been run continuously for months. The battery was invented by Mr. George E. Hatch, of Quincy, Mass., in 1890, and is covered by United States patents. Since the invention continuous experiments have been made with the battery, both in the laboratory and in practical work. Mr. Hatch uses light, porous earthenware plates, and places the active material upon them, clamping and binding the plates together by means of light wooden boards and flexible rubber bands. Between the earthenware plates are very thin lead sheets provided with lugs at the top which serve to form electrical connection between the elements. The advantages claimed for this method of construction are greater strength, lightness, elasticity—to allow for expansion and contraction—and the positive security and stability of the active material. It is claimed that the battery is entirely unaffected by the jolting of street cars and railway trains, and that extremely heavy discharge rates do not affect its life or cause its depreciation.

Preventing Electrolytic Corrosion.—A correspondent in an American contemporary says that the old scheme of connecting pipes to the negative pole of the dynamo, as advocated by some, gives but slight and temporary protection to the pipes, for electrolytic corrosion will take place when the pipes are even a hundredth of a volt positive. Such advice, he remarks, would cause great loss to any large railway company adopting it, and would be of little permanent value to any gas or water company. It might possibly help the operation of the telephone exchanges, but such help could be obtained in a less expensive and wasteful manner. He fully agrees with Mr. Edison in stating that he knows of but one practical method of stopping the destruction of the pipes, which, at the same time, effects a large saving of power to the railway company adopting it, for, of course, the work expended in reaching, corroding, and leaving the pipes is entirely lost. This is the process used by the Board of Street and Water Commissioners at Newark, N.J., U.S.A. Here the outgoing or positive current is carried to the trolley wire, but the negative terminal of one dynamo is disconnected from the rail return wire and joined to a wire leading to the points on the pipes which suffer the greatest amount of corrosion. The electrical pressure of this dynamo is then increased until the pipes are made two or three volts negative to the rails at the points which were previously positive, and were therefore corroded. As long as the pipes are kept negative to the rails there can be no more corrosion of the pipes, and the problem is solved.

Power Required for Electric Traction.—In an article in the *Sibley Journal of Engineering*, Mr. James Lyman gives the results of a number of tests made in different cities of the power required for electric traction. At Rochester, where the first of Mr. Lyman's records was obtained, there are about 20 miles of track, which was in good condition at the time of the test. The number of cars on the road was 40, each weighing about eight tons, and provided with a 15-h.p. geared motor. In general, the road was level, but in the heart of the town there were some gradients of from 3 to 4·7 per cent. Moving on the level, the necessary tractive power averaged 38lb. per ton of car, and for the whole run over the four principal routes, at 6·5 miles per hour, the average horse-power was 1·4 per car, and the maximum 6 h.p., this latter only being used momentarily. At Buffalo the same average power was required, but the maximum was 6·6 h.p. In a large Western city a car with the axles coupled direct to the motor, without the intervention of gearing, took 0·92 h.p. per ton on the average, with a maximum of 4·7 h.p. In wet weather the tractive power required is reduced, the rain acting as a lubricant. Wetting of the rails round curves is said to be particularly effective, the requisite traction power being thereby reduced by one-third. Comparative experiments made at Ithaca, N.Y., showed that on gradients the tractive force required exceeds that on the level by more than the theoretical amount.

Electrical Opportunities in Japan.—In a recent article in a Chicago newspaper Mr. William E. Curtis states that he has been assured by the Japanese Minister of Agriculture and Commerce that the Government is decidedly against granting to foreigners concessions for any form of transportation or communication, or for any public improvements or conveniences. The Minister explained that the friction between the telephone, electric light, gas, water, railway, street car, and similar companies and their patrons was already becoming troublesome, and that Parliament would very soon be compelled to enact laws similar to those in the United States for the regulation of such enterprises. It would, he added, be much easier to control and restrict them if they were owned by citizens of Japan. Foreigners would naturally appeal for protection to the diplomatic agents of their governments, and perplexing complications might ensue. Therefore, the Ministry, which had given the subject long and serious consideration, had decided not to allow the control of any public works to be placed in the hands of foreigners. There was no objection to the investment of foreign capital in their stocks and bonds, but the management must be strictly native, and laws would probably be passed requiring all directors of such corporations to be subjects of the empire. Numerous companies have been organised for the construction of electric railways in Japan, and many of them will doubtless carry out their plans in the immediate future. One proposes a trolley line in Yokohama, another an extensive system in Osaka, the most enterprising city in the empire and the second in population. Another contemplates the extension of the present trolley line in Kyoto, which is the only one in Japan. Similar enterprises are on foot in Nagoya, Kobe, Nagasaki, and other places. There are also applications before the Government for electric lines between Yokohama and Tokyo, a distance of 18 miles, and between Kobe, Osaka, and Kyoto, a distance of 48 miles.

The Murphy-Pierce Sub-Trolley System.—The electrical railway system devised by Messrs. John M. Murphy and Albert F. Pierce, of Danbury, Conn., is described in the New York *Electrical Engineer* of November 27. It dispenses with the overhead wires and the conduit underneath the car. The surface only of the road is used, and the car takes the power from the section of

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rail directly beneath it. Between the rails on which the car runs is a third rail, laid in short sections, each section being perfectly insulated from every other section. The car, in passing, automatically engages the section of this third rail directly beneath it, and from it takes the power. This is done by one wheel of the car which touches a push-pin, thus operating mechanism placed underneath the rail, which in turn makes the connection with and charges the section of rail over which the car is passing. As the car moves forward and touches another pin, the section in the rear is cut out the same instant the one forward is charged. The main or feed wire, insulated, is buried along the outside of the track. From this feed wire, insulated wires run to each section of the rail from which the car derives its power. These wires pass to the section through the mechanism by which the connection is both made and broken. The mechanism is simple, consisting of a lever, a pawl, a wheel, a shaft, and an electrical switch. All of this mechanism is encased in a box cast especially for it, watertight as well as dust-proof. There is a fuse-box between the wire and every section of rail, which makes it impossible to charge the rail up to the danger point. Any more than the required voltage burns the fuse and makes the rail dead. The charged rail is never exposed from underneath the car. All the mechanism used is cast in the foundry, making it comparatively inexpensive, and also possible to replace any part at a moment's notice. The electrical connection is made and broken by mechanical means. There is no magnetic switch device. An experimental section has been laid at Westport, Conn. It will be seen that this system has much in common with others brought out.

The Hargreaves-Bird System of Electrolysis.—A paper on the Hargreaves-Bird system of electrolysis was read on Monday before the London section of the Society of Chemical Industry. The paper was illustrated by one of the cells used at the experimental works at Farnworth. The author showed that by the use of diaphragms a degree of purity could be obtained superior to that yielded by the Leblanc process without the use of such a dangerous and poisonous material as mercury. The possibility of obtaining such results had been denied, and theoretical data given to justify the denial, but, nevertheless, the author said, it was now an accomplished fact. His experiments had led him to the conclusion that ionic migration was not bilateral, but unilateral. To perform the chemical work by direct electrolytic action required less fuel and labour than by the use of a succession of processes requiring the intervention of secondary reagents. The seeming absurdity of yesterday was now becoming a serious competitor to the older system. In the discussion, Sir Henry Roscoe complained of the course taken by Mr. Hargreaves in depreciating the Castner process. His accounts of the mercury lost and the sanitary effects of its employment were gross exaggerations. Dr. Hurter also complained of the spirit in which Mr. Hargreaves had criticised a paper read by him in Liverpool in 1888, and showed that the accepted theories were quite sufficient to account for the results obtained in the cell then exhibited. In reply, Mr. Hargreaves said he had condemned a mercury process of his own, after spending considerable time upon it, for exactly the same reason that he condemned all other mercury processes. The final result, however, was that they had not only done without mercury, but obtained a greater value of products from a given power. The mercury losses quoted were less than those given by Mr. Castner himself. His description of the evils produced by mercury could be supported by volumes of evidence. As to migration theories, the whole question was too nebulous to build any secure hypothesis upon. He gave his own ideas as nothing more than scientific guesses, which might or might not be confirmed in future.

Technical Education.—The Duke of Devonshire presided on Tuesday at the annual meeting of the National Association for the Promotion of Technical and Secondary Education, held at the United Service Institution. The report, which was presented by Sir H. Roscoe, was adopted. The Duke then opened a conference of representatives of technical education committees of county and borough councils. He explained the circumstances which had led to the holding of the conference, and said that its postponement from July had been attended with the effect of converting him from a private and irresponsible individual into a member of the Government, responsible both to his colleagues and to Parliament. This circumstance compelled him to abstain from offering any suggestions which might be construed into an announcement of the intentions of the Government. He hoped, he said, that the conference might give them something in the nature of a review of that part of the question of secondary education which was concerned mainly with technical instruction from the point of view of those concerned in its administration. The conference then proceeded to discuss the subjects of evening continuation schools, scholarships, and trade and technical classes. Lord Playfair, in closing the discussion, said that advance in technical instruction was important to the progress of this country. The prices of almost all machine-made commodities had fallen by 30 per cent. during the last 25 years. This had produced dislocation of labour and want of employment. Depression had been due to the fact that the world had not been able to adjust itself to the wonderful changes science had made in production and distribution. Since 1856 aluminium had fallen in value from 360s. to 2s. per pound. The cost of transport had been so far reduced that the flour in a quartern loaf was brought four or five thousand miles for a halfpenny. We must, he remarked, enable our people to adapt themselves to these changes and so to maintain the position of this country.

The Cantor Lectures on Horseless Carriages.—Mr. W. Worby Beaumont gave the second of his Cantor lectures on "Mechanical Road Carriages," at the Society of Arts, on Monday. After suggesting that among the reasons why in the earlier part of this century steam carriages, in spite of the success achieved with them from a mechanical point of view, failed to establish themselves in this country were the facts that the available capital was being absorbed in railways and the people were not really ready for them, the lecturer proceeded to deal with the development of steam road locomotives and traction engines. It had been thought that the attention paid to these in what might be called the second period of the nineteenth century mechanical carriage enterprise had delayed the development of steam carriages. However that might be, it was true that for many years very little was done towards the production of a comfortable carriage, the energy of inventors being all devoted to the construction of traction engines. The lecturer then described some of the machines which were designed by such men as Worby, I. W. Boulton, Tangye, Aveling, and others. In conclusion, he remarked that at present there was a demand for vehicles to carry goods and passengers, and there was every reason to believe that a really good carriage of not too expensive and complicated a design would be taken up by capitalists willing to invest in its manufacture. In the adjourned discussion on Wednesday evening on the paper read by Mr. H. H. Cunynghame on "Locomotive Carriages for Common Roads" at the Society

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of Arts, Mr. J. Wolfe Barry, C.B., F.R.S., being in the chair, Mr. Alexander Siemens said that if engineers had a chance they would be able to effect great improvements, provided that the public took the matter up. He instanced the great advances that were made in the supply of electricity after the removal of the comparatively severe restrictions. He thought the problem of constructing heavy vehicles should first be attacked, and suggested the substitution of mechanical omnibuses for the present vehicles. Mr. Yeaman, again, in the light of experiments that had been carried out, saw no reason why electrical omnibuses should not run from Hammersmith to Liverpool-street with accumulators of the types now in use, without relying on some problematical light accumulators not yet on the market; while Mr. Beaumont said it seemed to be assumed that we should easily get existing restrictions removed, but he thought that unless everyone did his best, it was not improbable that a Bill would be rejected.

Electric Mains and Roadways.—At last Friday's meeting of the Institution of Junior Engineers, held at the Westminster Palace Hotel, Mr. H. B. Vorley in the chair, the paper read was on "Urban Roads and Footways, with Notes on Gas, Water, and Electric Mains, etc., in connection therewith," by Mr. J. Julian, of the borough engineer's office, Cambridge. After a few preliminary remarks as to the original laying out of roads, the author considered their formation as executed principally by local authorities before taking them over. In macadamised roads, it was more economical to strengthen the foundation than to use a thick layer of other material between foundation and surface. The materials employed for foundation and, to a somewhat lesser degree, for surface were shown to be governed by local circumstances. Examples of cost in three localities amounted to practically the same per yard super—4s. 3d.—but the problem in most places was, perhaps, to produce a road as good as possible for a fixed figure, the various items varying considerably. Details were also given of the total cost per yard super of pavings on concrete foundations—viz., granite 11s. 9d., hard wood 15s., and asphalte 11s. The limiting gradients in ordinary cases were—asphalte 1 in 60, wood 1 in 25, macadam 1 in 20, and granite 1 in 15, but there were instances of macadam roads as steep as 1 in 6. Channelling, kerbing, and paths were then dealt with, and the common roadwork section of the paper concluded with some figures as to the covering capacity of stone and quantities of granite to the ton. Proceeding then to consider the laying of tramways, it was shown how great was the proportion which the roadwork bore to the other expenses of tramway track construction. A brief description followed of the overhead and conduit electric and the mechanical cable systems, and the underground works of a road were then reviewed. Various modes of laying electric mains were described, and particulars were given as to cost and of methods for determining the size of conductor and other data. Water and gas mains were then noticed, and with reference to them the author presented several formulæ for obtaining first approximations. Details of joints were illustrated, while an estimate for laying a pipe main showed the importance of taking into account the cost of restoring the road surface. Attention was finally directed to hydraulic, pneumatic, and steam power mains. In the discussion which ensued, Messrs. R. W. Newman, E. A. Berry, C. Mittelhausen, S. Boulding, F. Fisher, W. R. Beckton, W. Cooke, and the chairman took part.

Mechanical Road Carriages.—There was a large attendance at the meeting held at the Cannon-street Hotel on Wednesday of those interested in self-propelled traffic and horseless carriages, in order to consider "the advisability of forming an association to deal with a subject which closely affects agricultural, trade, and private interests." Sir David Salomons, Bart., who presided, said that in 1875 he started making an electrical bicycle, but as there was no accumulator the matter fell to the ground. Referring to the recent exhibition of self-propelled vehicles, he stated that he received in connection with it an enormous mass of correspondence. He had collected cuttings on the subject from about 300 newspapers, and 90 per cent. of them were in favour of the new mode of traffic, 8 per cent. were practically neutral and said "wait," and 2 per cent. were adverse on sentimental grounds. If he had been a manufacturer, he could easily have sold many hundreds of these carriages. Opposition to the movement, he asserted, would of course come from two classes—those who would deplore the disappearance of the horse, and those who said that the new vehicles would not want oats. At the present time, however, the foreigner competed with this country as regarded horses, and as to oats, more than nine-tenths of the quantity used was brought from abroad. The money thus expended would be retained for the benefit of our own countrymen if these self-propelled carriages could be made in England. He felt sure that the present Government would look favourably upon the movement. By the introduction of this means of traffic the streets would be clearer and cleaner, and there would not be the present continual demands for new and wider streets, as the block of traffic which caused such demands would disappear. He concluded by moving a resolution expressing the desirability of forming the Self-Propelled Traffic Association, and incorporating it with £1 liability under the Companies Act. Mr. Cumming Macdona, M.P., who seconded the motion, remarked that he went to Paris purposely to see how these motors were made, and he found no fewer than nine large manufactories in full work. A great country like ours ought not, he affirmed, to be in the background in such a matter, but this would depend on Parliament removing the obnoxious Act which prevented us from having the same facilities in this country as those which existed in France, Germany, and America. Mr. Bertram van Praagh said that when they saw those carriages going through the most crowded streets and boulevards in Paris without frightening a horse or disturbing the traffic in any way they must recognise that, sooner or later, they would have an equal hold here, and that if England were not to be left behind they must bestir themselves here. To show what the new machine was capable of he mentioned that the carriage had been driven from Marseilles to La Turbie, and had been got along rough roads, through snow, and up inclines without difficulty. The motion was carried unanimously. The chairman then proposed a resolution appointing an executive, consisting of a president, four vice-presidents, and 30 members, and, on the motion of Mr. G. N. Hooper, Sir David Salomons was appointed president; Lord Winchelsea, Sir F. Bramwell, Mr. Alexander Siemens, and Mr. John Philipson were elected the four vice-presidents if they would serve; and the following gentlemen were appointed members of the council: The Hon. Evelyn Ellis, Sir Albert Rollit, M.P., Sir H. T. Wood, Colonel Mellor, Prof. Boyd, Mr. Jacobs (vice-president of the Institution of Carriage Manufacturers), Mr. Shipton (Cyclists' Touring Club), Mr. Marshall (Gainsborough), Mr. George Stephenson (Newcastle), Sir Richard Tangye, Sir Benjamin Brown, Mr. William Cross, Mr. M'Naught, Mr. Rucker, Mr. Lawson, Sir Benjamin Richardson, Mr. Irving Courtenay, Mr. Knight, and Mr. Walter Hancock.

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CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XIX.

(Specially Contributed.)

The Mirror Galvanometer.—Before describing the instruments used with large currents, which are mostly modifications of the tangent galvanometer, it will be best to point out that in the early days of telegraphy the currents used were very small indeed, as they are in many of the experiments made in laboratory work. The instruments required for these delicate experiments are altogether different from those required in an electric light station. We in these latter days have to do with amperes; the workers in those days thought and spoke of and used milli-amperes, or less current. Some of the instruments used in laboratory work are of the astatic form, and have coils of many turns, with resistances of thousands of ohms. Even with the many coils and their cumulative action upon the needle, it would be difficult to read the needle point upon the scale with the desired accuracy; hence means were devised to increase the size of the scale divisions, and so allow of more accurate reading. In fact, the galvanometer, like any other measuring instrument, must be modified to suit the particular class of measurements for which it is to be used. Thus, for large currents we must have wires to carry such currents without fusing or heating, and coils of a few turns will probably suffice; while with very weak currents we may have very many coils of fine wire, the total resistance of such fine coils sometimes reaching to 10,000 or 12,000 ohms. It is unnecessary to dwell upon these simple things; the common-sense observations of the student informs him of them. We do not measure miles with inch tapes, nor weigh bridge girders with ounce weights. Thus, while describing a number of instruments it must be remembered these are but a few from a large number in which the principles are the same, but the details may be widely different according to the purpose for which they are intended. The mirror method of reading, which prevails in most modern instruments, was originally suggested by Poggendorff, and carried out in practice by Gauss and Weber on the Continent and Lord Kelvin (then Sir W. Thomson) in this country.

Light Rays—Incidence—Reflection.—Luminous bodies are those which are seen by the light they themselves give out. Other bodies are seen by means of the light they receive and reflect from the luminous bodies. For our purpose we may define a ray of light as a line of light. A ray of light will proceed in a straight line unless interfered with by a change of medium through which it passes. A transparent body is one that allows light rays to pass through it, while an opaque body does not allow the light rays to pass through. However, there is no body perfectly transparent or perfectly opaque. More scientifically, we might say that when a ray of light falls upon a body it is either—

1. Reflected.
2. Absorbed.
3. Transmitted.

In no case is there total absorption or transmission; there is always a portion reflected or thrown back. Any body that absorbed or transmitted the whole of the light falling upon it would be invisible, for, as I have stated, we see things by reason of the light reflected from them to our eyes. Again, if any body perfectly reflected the light falling upon it, that body would be invisible except to eyes in the path of the reflected rays. Therefore, there is no body which is a perfect reflector, for we know that the best reflectors can be seen from almost or quite all directions. This simply means that reflectors are not perfect, but the laws may be stated as if they were perfect.

A ray of light striking a reflecting surface is reflected or thrown back in a direction depending upon the angle at which it strikes. Suppose the reflecting surface to be that of a perfectly plane mirror, and suppose a series of lines be drawn perpendicular to the plane of the mirror. Let A B, Fig. 1, represent such a mirror and C D a perpendicular. Now, if a ray of light falls upon A B from D in the direction D C, it will be reflected back again along the perpendicular C D; but if the ray of light falls upon A B from some other point, I, along the line I C, it will be reflected in the direction C R, a direction in which the angle I C D is equal to the angle D C R.

The angle I C D is called the angle of *incidence*;
„ „ D C R „ „ „ „ „ *reflection*;
and the *angle of incidence is equal to the angle of reflection.*

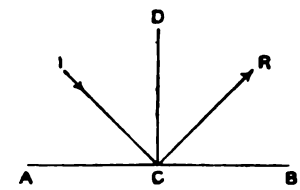

Fig. 1.

This law has proved of great use in the construction of electrical instruments. It can easily be understood that when using very small currents the weight that can be given to a needle moving under the influence of the current must also be very small, and the motion of the ends of such a small needle could not be read with any accuracy upon the scale it would be necessary to use. To overcome this difficulty, Lord Kelvin (then Sir W. Thomson) designed a galvanometer to the needle of which was fixed a very light mirror. In this instrument, as the needle moves, so the mirror moves. If then a ray of light is made to fall perpendicularly over the mirror, when the needle stands at zero it will be reflected straight back. If, however, the needle, and hence the mirror, be moved through any angle, the reflected ray will no longer be reflected along the perpendicular, but in some other direction determined by the magnitude of the angle through which the mirror moves. I have already given you the law of incidence and reflection, but with this apparatus you can see its truth clearly.

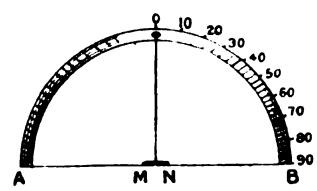

Fig. 2.

A B O (Fig. 2) is a semicircular scale. At O is a small hole through which a small beam of light passes and falls perpendicularly on to a mirror, M N. Instead of the mirror, M N, I will use this pointer (Fig. 3), to which is fixed a

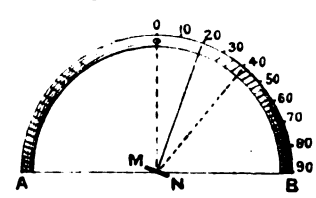

Fig. 3.

similar mirror. When used with the pointer pointing to zero, the light falls perpendicularly on to the mirror, and is reflected back to O; but when I put the pointer in any other position, the mirror it carries is moved through the angle indicated by the pointer—say, 20deg.—but you see the spot of light is reflected to the division marked 40deg.

The mirror being rigidly fixed to the position, the top of the pointer is always perpendicular to the plane of the mirror, and in the position shown the *angle of incidence* is 20deg.; but according to the law given the *angle of reflection* is also 20deg., hence the spot of light is seen on the division marked 40deg. However I move the mirror and pointer, this is always seen to be the case; hence *the angular deflection of the reflected ray is double that of the mirror which deflects it.* From this you see a second advantage in using a ray of light as pointer:

First, it has no weight.

Second, its angular motion is double that of the moving needle and attached mirror, admitting larger scale divisions, and so more accurate reading.

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D'Arsonval Galvanometer.—Fig. 4 shows the principle of this instrument, in which a moving coil takes the place of the small moving magnet in other instruments. M is a strong permanent magnet, between the poles of which, to shorten the air-gap and so decrease the resistance of the permanent magnet's magnetic field, is a soft iron core, F. A light rectangular movable coil, C, is suspended above by the fine wire, W, of silver or phosphor bronze, carrying the mirror, G, and also used to conduct the current from the positive terminal to the coil. The current is conducted from the coil by a similar wire, W, terminating in the mercury-cup, A. The mercury is connected by a conductor to the negative terminal of the instrument. In the adjoining illustration the coil, C, is shown deflected for clearness sake; in the normal position it is practically at right angles to the position shown. We shall see from subsequent chapters that this instrument is similar to an electric motor, the coil or armature carrying the current revolving in the surrounding magnetic field. In

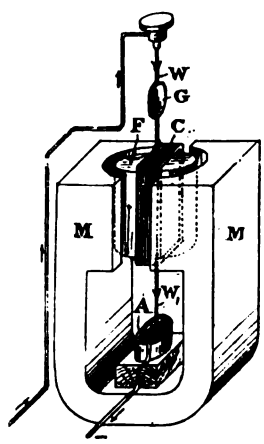

FIG 4.

this instrument the field of the permanent magnet is made very strong compared to the field of the coil, so that the turning speed of the latter is very small, and so the spot of light from the mirror on the scale moves slowly to its furthest point, and then, instead of oscillating, comes quickly to rest. Instruments of this kind, where the motion of needle or coil comes to rest quickly and without oscillations, are called *dead beat* instruments. We are in too great a hurry nowadays to want to waste time waiting for oscillations to cease, hence dead-beat instruments that come to a full stop quickly are well adapted for general use.

Holden-d'Arsonval Galvanometer.—This galvanometer, as shown complete in Fig. 5, and with its cover

FIG. 5

removed in Fig. 6, is a development of the well-known d'Arsonval dead-beat zero instrument. In the improved galvanometer we have a powerful laminated permanent magnet of circular form, and placed horizontally. The poles of this magnet are brought round to face one another, and are turned out so as to encompass the moving coil. In the centre of the magnetic field and midway between the poles, a cylindrical rod of very soft iron is placed, serving as a medium for concentrating the lines of force, and making the magnetic field quite uniform. The moving coil is built upon a light silver frame, and is wound with No. 40 silk-covered copper wire, and when mounted with its suspending wires it has a total resistance of about 16 ohms. The current is led into the coil by means of the suspended platinoid or phosphor-bronze wire, starting from a spring at the top of the instrument and passing out through another wire fixed at the bottom and attached to a mill-headed screw. The spring holding the top wire serves to give the necessary tension. The bottom screw-nut is used to produce the desired torsion to bring the mirror to the zero mark. A special point about this instrument is an arrangement for lifting out the coil and its enclosed iron core, and thereby affording a ready means of renewing the suspension wires or mirror, and making other adjustments. By simply unscrewing a clamping screw, and removing one connecting wire from a binding

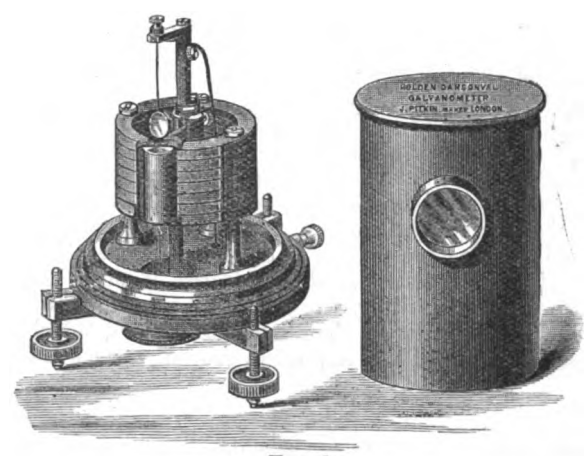

FIG. 6.

clamp, the whole coil system can be removed. The advantage of this arrangement is apparent, as a number of different resistance coils may be supplied with each instrument, and at the same time it reduces the chances of damage in transit. With a coil having a resistance of 16 ohms and an added resistance of 100,000 ohms, a deflection of the coil equal to an angle of 1deg. may be obtained with a pressure of one volt. As the scale is found to be of practically equal divisions, the instrument may be used as an ampere or voltmeter by the addition of suitable shunts or resistances.

Damping.—Dead-beat instruments are obtained by decreasing the extent of the oscillations of the magnetic needle. Naturally, there is a damping action arising from the dissipation of energy through the resistance of the air, also from the action of currents induced in neighbouring metallic circuits, and from the viscosity of the suspending fibre, etc. These, however, do not usually produce a dead-beat instrument, so that other means of damping are employed. The late C. Varley immersed the needle in a cell filled with a liquid. In older instruments, pieces of copper were put around the magnet. It can easily be seen that the resistance to motion of a liquid is greater than that of air, so that with Varley's method the needle would be sooner brought to rest. The action of the copper will be explained later on. Wiedemann makes the needle of his tangent galvanometer ring-shaped to swing in a ring-shaped cavity, but much larger than itself in the midst of a mass of copper. Lord Kelvin puts magnet and attached mirror in a flat cell, in which it can just move freely to the required extent. The damping due to the pumping of the air backwards and forwards round the edges of the mirror is so great that the needle swings off to its position of equilibrium and remains there without oscillating at all.

A Tall Chimney.—We learn from the New York *Electrical Review* that the Edison Electric Illuminating Company, of Paterson, New Jersey, have just completed a chimney 230ft. high at their works. The chimney took only about 40 days to build.

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CROMPTON IMPROVED BIFILAR D'ARSONVAL GALVANOMETER.

The researches of Mr. R. E. Crompton into the advantages of the potentiometer method of measuring currents and electromotive forces naturally led to the enquiry as to what limited the accuracy of these measurements. The ruling principle being a determination of equipotential points, the sensibility of the galvanometer is a most important factor, and hence an attempt was made to break the record in this direction. The instrument of the D'Arsonval type now under consideration is certainly the most sensible of its kind to small deflecting forces. Of course, the instrument is not designed to give a proportional scale, as a deflection from zero one way or the other is all that is required. When adjusted for maximum sensibility, one-millionth of a volt will produce a centimetre deflection on a scale 200 centimetres from the instrument. This voltage is obtained by placing one-hundredth of an ohm in series with 20,000 ohms across an accumulator and attaching the galvanometer leads to the two ends of the small resistance.

This instrument is illustrated by the figures adjoining, which give some idea of the construction. The permanent magnets are of the horseshoe type, built up of four laminations which are secured to the base by the clamping-bolts. The bolts are hollowed out to receive a circular coil, A (Fig. 1), and a circular core, C, helps to reduce the resistance of the magnetic circuit. The base is made of solid brass, and the levelling screws are of a somewhat novel type. They consist of ebonite-headed screws, the ebonite being cone shaped and stepped to prevent surface leakage.

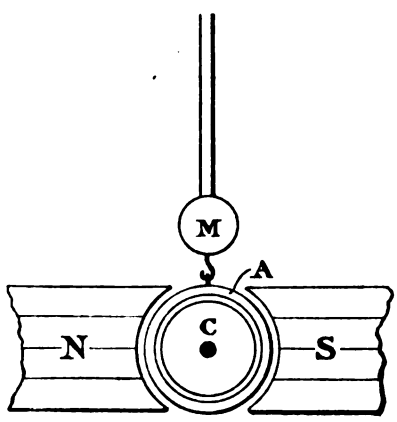
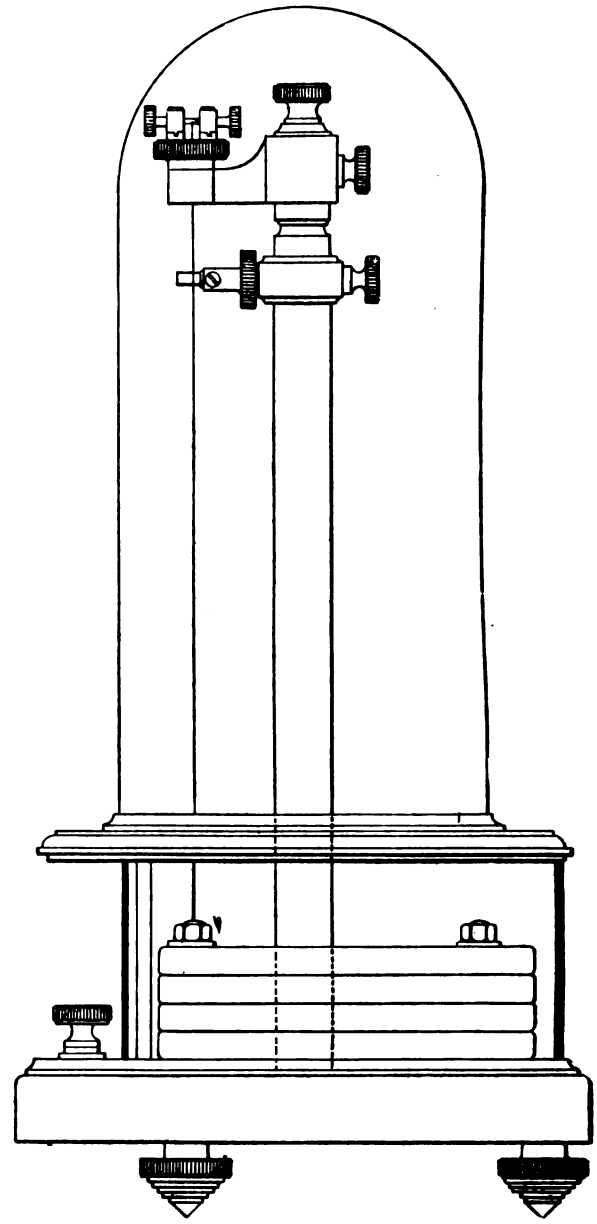


FIG. 1.—Front View of Coil and Mirror.

The pillar forming the support for the bifilar suspension is made of a stiff tube screwed into the centre of the brass base. The suspension is effected by means of two phosphor-bronze strips made by rolling out flat a wire of one mil diameter. The strips are attached to two pins working in conical holes of the fiddle-peg type, which are placed on the ebonite sleeve carried at the upper end of the pillar. This circular ebonite sleeve has a milled rim, and a fine slot is cut into the central hole, so that the suspension strips can be passed through it after the conical pins have been attached. The sleeve is then rotated into the correct position, which closes this slot. The projecting arm carrying the bifilar suspension is fixed to the central pillar by a long sleeve, which allows of vertical adjustment. An adjustment in the active length of the bifilar suspension is also provided by a thin strip of insulating material, which also slides on the pillar. This flat strip projects between the two suspension wires, and when parallel to them it does not touch the wires. When rotated, however, it touches them both, and thus shortens the effective length of the suspension. In this way the period of the coil and the sensibility of the galvanometer is altered (Fig. 3).

The coil is of the ring type. It is wound upon a wood former, which is subsequently removed, and is suspended by means of two metallic loops at the front and back to two hooks attached to the suspension under the mirror. The removal and fixing of a new coil of different turns or resistance is hence an easy matter. The clamping device for securing the coil for transit is attached to the core, which also is supported from the central pillar by an arm.

FIG. 2.—Elevation of Crompton's D'Arsonval Galvanometer.



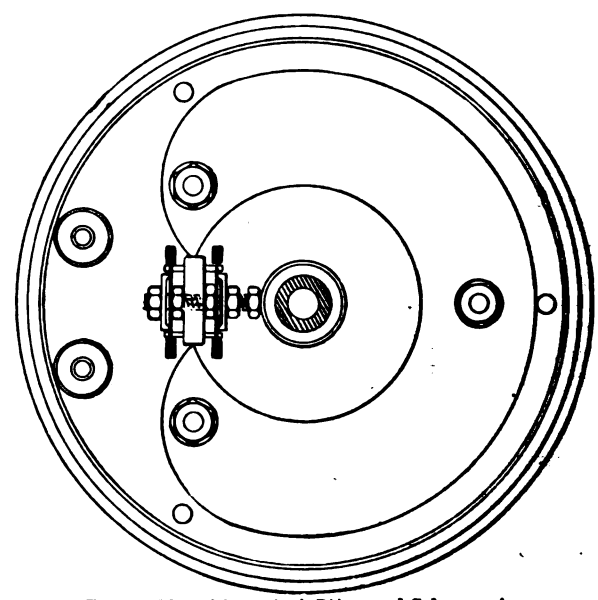


FIG. 3.—Plan of Crompton's D'Arsonval Galvanometer.

It is set in position on the arm by means of two nuts, one at back and one at front. Outside the nuts are two light springs tipped with rubber, which are kept in position by

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pins in the core. They clamp or limit the movement of the coil by means of the undercut washers moved up by nuts. The washers bend the springs, and by adjusting the nut any desired limit can be given to the movement of the coil. These washers and springs can be seen in the plan (Fig. 3).

The terminals are insulated by insulating collars and discs from the base, and are connected by leads running up centre of pillar to the bifilar attachment. The whole is protected from injury by the brass guard shown, which has a portion cut away in front of the mirror. A sheet of pure plate glass is placed there in order to obtain a well-defined image. A portion even of this glass screen is in some instances cut away, and a disc of microscopic film glass, about one-hundredth of an inch thick, cemented over the opening. The whole is surmounted by a French glass shade.

The periodic time of the coil with the full length of the suspension is 6·5 seconds. The real object of the whole design is to obtain a strong magnetic field where the coil is placed, so that an extremely small current will give a deflection. This strong field, however, as shown by the careful research of Messrs. Ayrton and Mather, tends with the ordinary coil to set up a secondary effect, which prevents great sensibility being obtained.

Referring to an article on the subject in our issue of October 5, 1894, we then said: "Great difficulties were, however, found to arise when the extreme sensitiveness sometimes required in the laboratory were attempted, though a good working instrument could be made to give 100mm. deflection with a millionth of an ampere. The difficulties were chiefly due to the traces of magnetism found to exist in the silk and other parts of the coil usually considered non-magnetic, and to the fatigue of elasticity or sub-permanent set of the fine suspension required in this case. A great number of trials was made at the Central Technical College, which showed that magnetism could be detected in almost all bodies by suspending them and noting the times of vibration within and without a magnetic field. The purest wire of electrolytic copper or of fine silver, specially drawn and covered, still showed traces, and a method of treating the coils was at length devised which has practically solved this difficulty. The non-magnetic property of the new coils allow a magnet to be used whose field is four times as strong as those originally used in this type of instrument."

This phenomenon was first noticed by Mr. Mather in December, 1891, and the magnitude of its influence can be gathered from the above test on a coil of a similar type to that referred to above. The coil to be tested was suspended in the earth's field, and the period of a complete oscillation was found to be 25·2 seconds. It was then placed in a field of 1,500 C.G.S. lines per square centimetre, and the period there was only 3·5 seconds. The coil thus made more than seven times the number of oscillations in a given time corresponding to a controlling force 50 times greater than before. The action can only be accounted for by the assumption that parts of the coil became magnetic, and it can easily be seen that this secondary effect is magnified in the D'Arsonval type of galvanometer, when, with the object of gaining sensibility, the magnetic field is strengthened so that a small value may be given to the ampere-turns in the deflecting coil—in fact, the magnetic action of the coil will defeat this attempt. We understand, however, that Mr. Crompton has adopted the means devised by Messrs. Ayrton and Mather of rendering the coils practically non-magnetic.

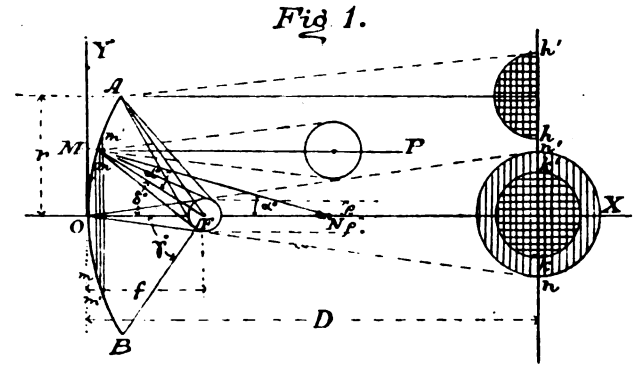
ON THE ILLUMINATION PRODUCED BY A PARABOLIC MIRROR BY MEANS OF A SPHERICAL AND OF A PLANE SOURCE OF LIGHT.

BY JEAN REY.

I. *The Source being Spherical.*—Let A O B, Fig. 1, be a parabolic mirror having its focus at F. Let M be a point on the mirror, M P the reflected ray coming from the focus, ρ the radius of a spherical luminous source placed in the focus, δ the angle made by the ray with the axis, and α the angle made by the normal either with the radius vector or with the axis. It is supposed that the luminous source follows Lambert's law, which need not be here enunciated. By virtue of this law, a luminous sphere appears to the eye as a plane disc, and a luminous spherical source is equivalent to a plane disc of the same diameter and the brilliancy of which is uniform. The luminous source under consideration has then an intensity which is constant in all directions. This intensity is equal to the surface of the plane disc multiplied by the intrinsic brilliancy—that is to say, by the brilliancy per unit of surface.

In order to facilitate these calculations, it is necessary to make an hypothesis which is perfectly legitimate—viz., that the size of the source is negligible in comparison with that of the mirror, or, in other words, the angles made by the rays leaving the edges of the source with the normal to a point on the mirror are to be considered as equivalent and equal to the angle made by the luminous ray coming from the centre of the source with the normal to the same point.

Fig. 1.



To evaluate the illumination produced in the central zone of the beam, it is necessary to calculate separately the illumination produced by each part of the mirror. If x and y be respectively the abscissa and ordinate of the point, M, the equation to the parabola when its vertex is taken as origin is $y^2 = 4fx$, f being the focal length. Let F M = l (the radius vector), and let us consider the surface of the elementary zone containing the point, M. If $m m'$ be an element ($d s$) of the parabola, then the surface of this zone is $2\pi y\, d s$. It receives light of which the intensity is "I," "I" being the constant intensity of the spherical source.

To obtain the flux of light falling upon the zone under consideration, we must multiply the intensity which it receives in the direction of the radius vector by the solid angle of this zone. This solid angle is the projection of $m m'$, in the direction of the luminous ray, divided by the square of the distance. (This from definition of a solid angle.) The value of this angle is therefore $\frac{2\pi y\, d s \cos a}{l^2}$

The flux through this solid angle is then $\frac{2\pi y\, d s \cos a}{l^2} \times \mathrm{I}$.

We must now find the illumination produced by this flux. Each of the points, M, reflects a luminous cone having as its base the image of the luminous sphere—that is to say, a plane disc of the same diameter as such a sphere. Each reflected cone has therefore a circular base. At a distance D the radius of the section of the reflected cone is $\rho \frac{D}{l}$, and the sectional area of the conical elementary beam is $\pi \frac{\rho^2 D^2}{l^2}$. Since now the elementary reflected conical beams proceeding from all points of the zone cross in space at even a moderate distance and form themselves soon into a single beam, we may consider that the zone under consideration produces at distance D a circle of illumination, which illumination is the flux received by the zone divided by the sectional area of an elementary beam calculated as above. This illumination is therefore:

$$\frac{2\pi y\, d s \cos a \,\mathrm{I}}{l^2} \div \pi \frac{\rho^2 D^2}{l^2} = \frac{2\,\mathrm{I}}{\rho^2 D^2} y\, d s \cos a.$$

As we approach the edge of the mirror, the luminous cones reflected from the elementary zones become more

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acute. The elementary zone at the very edge of the mirror produces the smallest circle of illumination, $h\,h'$. It is precisely this circle which governs the dimensions of the central zone, $k\,k' = h\,h'$. As all the other zones produce larger circles of illumination which superimpose themselves on the circle, $h\,h'$, it is only this latter circle which receives light from all the zones of the mirror. On the other hand, the centre of the mirror produces a large circle of illumination, the edge of which, $n\,n'$, receives light only from the centre of the mirror itself. To obtain, then, the illumination of the central zone of the beam, it becomes necessary to find the sum of the illuminations produced by all the elementary zones of the mirror—that is, it is necessary to integrate the expression $\frac{2\,I}{\rho^2\,D^2}\,y\,d\,s\cos\alpha$ and between the limits $y=0$ and $y=r$ (the semi-diameter of the aperture of the mirror). It is clear that $d\,s\cos\alpha = d\,y$, and the illumination of the central zone becomes :

$$\frac{2\,I}{\rho^2\,D^2}\int_{y=0}^{y=r} y\,dy = \frac{2\,I}{\rho^2\,D^2}\times\frac{r^2}{2} = \frac{I}{\rho^2\,D^2}\,r^2.$$

If i be the intrinsic brilliancy of the source, then $I = \pi\rho^2\,i$, and if we call the illumination of the central zone E,

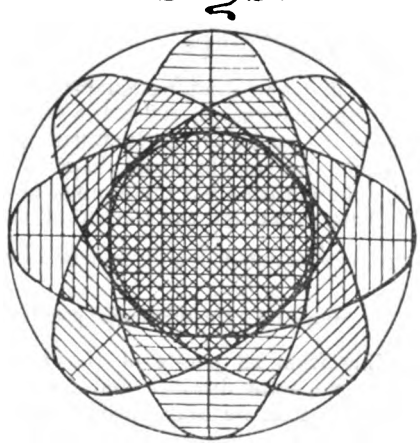
$$E = \frac{\pi\,\rho^2\,i}{\rho^2\,D^2}\times r^2 = \frac{\pi\,r^2\,i}{D^2} \text{ or } \frac{i\,S}{D^2},$$

where S is the area of the aperture of the mirror. We may say, then, that the optical power of the mirror, $E\,D^2$, is $i\,S$, or the intrinsic brilliancy of the source multiplied by the area of the aperture of the mirror. For a spherical source of given intrinsic brilliancy, the optical power of a parabolic mirror is therefore constant, and is independent of the focal length.

II. *The Source being Plane.*—If the luminous source be plane, and follow the law of Lambert, the intensity in a direction making an angle δ with the axis is $I_0\cos\delta$, where I_0 is the intensity normal to the plane source. This is exactly what happens with electric arc lamps, and be it well understood there exists no such thing in reality as a spherical luminous source.

Let us now consider a point of our parabolic mirror illuminated by a plane source. The point is illuminated by a cone of rays having the plane circular source as its base. The right section of this cone through the focus is, however, no longer a circle, but an ellipse, the major axis of which is 2ρ and the minor axis of which is $2\rho\cos\delta$. The point, M, reflects a luminous cone, the right section of which in space is a similar ellipse. Now, the dimensions of the mirror are small compared with those of the circle illuminated, at any considerable distance, and we may therefore suppose, as far as the illumination of such a circle be concerned, all points of any one zone of the mirror to be

Fig. 2



concentrated at the centre of the mirror. These points will consequently produce a series of elliptical reflected cones, the right sections of which have the same dimensions, but which are situated with regard to one another as indicated in Fig. 2. We see, then, that all the elliptical cones of which the whole beam of the zone is built up have one common part, which is a right cone having for diameter of base the minor axis of these ellipses.

Let us now calculate the illumination produced by the circular zone, $m\,m'$, $m\,m'$. Its solid angle is, as we have seen, $\frac{2\,\pi\,y\,d\,s\cos\alpha}{l^2}$. The flux received by this zone is now, however,

$$\frac{2\,\pi\,y\,d\,s\cos\alpha}{l^2}\times I_0\cos\delta = \frac{2\,\pi\,y\,d\,y\cos\delta}{l^2}\,I_0.$$

This flux, after reflection, falls upon an ellipse whose axes, at a distance D, are $2\,\rho\,\frac{D}{l}$ and $2\,\rho\cos\delta\,\frac{D}{l}$. The area of such ellipse is $\frac{\pi\,\rho^2\,D^2\cos\delta}{l^2}$. The illumination is therefore

$$\frac{2\,\pi\,y\,d\,y\cos\delta\,I_0}{l^2} \div \frac{\pi\,\rho^2\,D^2\cos\delta}{l^2} = \frac{2\,I_0\,y\,d\,y}{\rho^2\,D^2}.$$

This expression is exactly the same as that obtained in the case of the spherical source, and if we again integrate between the limits $y=0$ and $y=r$, we obtain the value

$$E = \frac{I_0}{\rho^2\,D^2}\,r^2 = \frac{\pi\,r^2\,i}{D}, \text{ or } \frac{i\,S}{D^2}.$$

Thus, in this case also, the luminous power of the mirror, $E\,D^2$, is the product of the area of its aperture multiplied by the intrinsic brilliancy of the source. In fact, whatever be the form of the source, the focal length will not enter nto the expression for the luminous power. For an ordinary lens, or for a Mangin mirror, it would be necessary to ascertain for each successive zone the exact divergence of the reflected cone ; the formulæ become very complicated, and integration becomes impossible.

The above will appear shortly in M. Blondel's new "Mémoire" on projectors ; it is rigorously exact as long as the size of the source may be considered negligible as compared with the size of the mirror. If the brilliancy of the source be not uniform all over, the value of the intrinsic brilliancy in the ultimate formula would be a mean which it would be necessary to evaluate also by the aid of the integral calculus ; but this would not change the basis of the reasoning.

THE REVISED REGULATIONS OF THE BOARD OF TRADE.

The following is the report of a committee appointed by the Board of Trade to consider whether it is desirable that the limit of low pressure as defined by the Board of Trade electric lighting regulations for the protection of public safety should be altered. The report is to be presented to the Right Hon. C. T. Ritchie, M.P., President of the Board of Trade. The committee, having duly considered the question referred to them, are of opinion—

1. That it is expedient to alter the definition of pressure in the above-mentioned regulations as follows—viz., first, omit the following words : "Pressure on any alternating-current system being taken to be the equivalent of pressure on a continuous-current system when it produces an equal heating effect if applied to the ends of a thin stretched wire or carbon filament." Secondly, in place of paragraphs (*a*) (*b*) and (*c*) substitute the following—viz, (*a*) "Where the conditions of the supply are such that the pressure may at any time exceed 500 volts if continuous, or 250 volts if alternating, but cannot exceed 3,000 volts whether continuous or alternating, the supply shall be deemed a high-pressure supply" ; (*b*) to be worded as existing ; (*c*) omitting "or the equivalent of 3,000 volts."

2. The committee further advise that the following amendments should be made in the proposed regulations—viz, (*a*) Regulation 1, to read as follows : "Save, as hereinafter provided, the pressure of a supply delivered to any consumer shall not exceed 250 volts at any pair of terminals." (*b*) Regulation 31, add "No such conductor shall be at a higher pressure than 300 volts from earth." (*c*) Regulation (6) for supply omit the words, "or less than 45 volts if continuous, or the equivalents thereof respectively if alternating." In place of "150 volts" read "250 volts." Add at the end the following proviso—viz., "Provided

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that no change shall be made in the pressure of the supply to any consumer in consequence of the issue of these regulations, except with his consent."

3. With reference to the suggested alteration to Regulation (31) for safety, the committee are of opinion that to enable the use of 500 volts continuous pressure between the outer conductors of a three or five wire system with bare conductors laid in conduits, the Board of Trade may give a provisional sanction to an earth connection being applied to one point of the middle conductor in any case in which they are satisfied that a high insulation is maintained on all other points of the system, and that suitable and sufficient means are provided for the immediate detection, localisation, and correction of any fault of insulation.

4. The committee consider that in making the above suggestions they have indicated clearly how, in their opinion, the question of limitation of pressure should be treated to adequately secure the safety of the public and to meet the requirements of electric lighting undertakers and the convenience of their customers.

They do not, however, wish to insist upon the exact wording suggested, and would leave the final drafting of these amendments, and any consequential verbal amendments of the draft regulations, in the hands of the Board of Trade.

(Signed) KELVIN.
" W. H. PREECE.
" P. CARDEW.

8, Richmond-terrace, Whitehall, December 2, 1895.

[Our readers, by referring to our issues of the 22nd and 29th ultimo, will find the clauses referred to and the discussion on them at the recent conference.—ED *E. E.*]

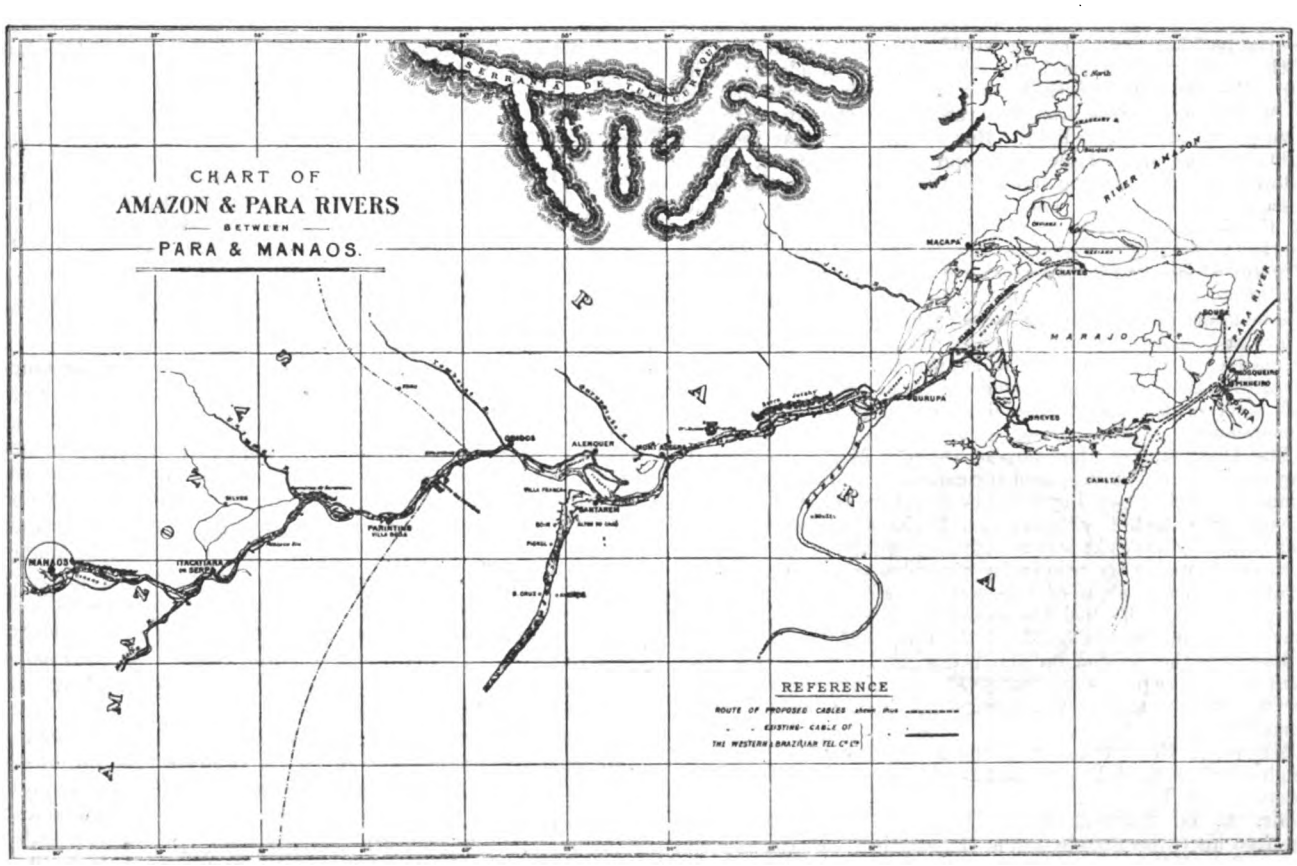
THE AMAZON CABLE.

A new and most interesting scheme for telegraphic communication in tropical countries has practically been commenced this week by the departure of the ss. "Faraday" with the city of Manaos, and also to provide communication with 14 other towns on the river. The map adjoining shows the route by which this cable is to be taken, and the branch lines connecting it to the following towns—*i.e.*, Pinheiro, Mosqueiro, Soure, Cameta, Breves, Gurupa, Chaves, Macapa, Alemquer, Monte Alegre, Santarem, and Obidos, in the State of Para, and Parintins and Itacoatiara, in the State of Amazonas.

In 1893 an attempt was made by the Brazilian Government to establish land lines between these ports, but owing to the difficulties met with in the forests and swamps bordering on the rivers, the lines had to be abandoned, after a great sum of money had been spent.

At Para the cable will join the land lines of the Brazilian Government and the Western and Brazilian Telegraph Company's cables connecting with the rest of Brazil and the Argentine Republic, and by the cables of the Brazilian Submarine Telegraph Company will be placed in communication with Europe and the telegraph system generally.

In order to avoid miscalculations, a preliminary survey was made of the proposed route, under the personal direction of Mr. Alexander Siemens, as representing the contracting firm. From the information gathered, it is stated that there should be no difficulty in placing such a cable in the river-bed, and that there were no reasons for apprehending trouble in maintenance. The great depth of the river will in most places afford protection. The fact that the "Faraday," a vessel of over 5,000 tons burden, and requiring 30ft. of water when loaded, is able to proceed up the river to Manaos, a distance of over 1,000 miles from the mouth, gives some idea of the size of the water-way. The work is being carried out by Messrs. Siemens Bros. and Co., Limited, on behalf of the Amazon Telegraph Company, Limited, which is heavily subsidised by the Brazilian Government for the next 20 years. The subsidy, however, ceases after that period, and in 30 years' time the system will revert to the Government. The contract for the construction and laying of the cables, and provision of apparatus, repairing machinery, etc., and transfer of the work to the company, was made in July last, the system being thus handed over complete and ready for work. The



Map Showing the Route of Amazon Cable.

for Para. The extremely rapid growth of vegetation in Brazil renders the maintenance of overland wires a very costly matter. A scheme was therefore devised of laying a cable in the bed of the River Amazon to connect Para specification for the work was approved by Messrs. Clark, Forde, and Taylor, the engineers and electricians to the company, under whose supervision the cables have been manufactured. The total length of the cables will be

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about 1,365 miles, and by the terms of the contract they are to be completed and laid by or before March 1, 1896.

The cable is mostly of the deep-sea type, but heavily armoured ends will be spliced on where the cable is brought to the bank, and hence is liable to chafing action. The steamer "Faraday," which is owned by Messrs. Siemens Bros. and used exclusively for submarine telegraphic work, was loaded with a large portion of the cable by the end of last week. Special ventilating arrangements have been fitted up to ensure a good circulation of air throughout the vessel when in the hot climate of the Amazon district. For this purpose a large number of electrically-driven fans have been provided. The expedition will be under the personal supervision of Mr. Alexander Siemens and Mr. J. R. Brittle. A number of distinguished visitors have been invited to witness this interesting departure in telegraph practice.

SHREWSBURY ELECTRICITY WORKS.

The formal opening of the Shrewsbury electric light works—a description of which appeared in our columns last week—took place on Tuesday. A party of the principal townsmen and others, to the number of about 90, assembled as invited guests to a luncheon in the Corn Exchange given by the contractors for the plant, Messrs. Edmundsons, Limited, of Great George-street, Westminster. The Mayor presided.

In proposing "Success to the Shropshire Electric Light and Power Company, Limited," Mr. W. H. PREECE, C.B., F.R.S., in the course of his remarks mentioned that various schemes had from time to time been mooted for introducing the electric light into Shrewsbury, but nothing definite had resulted until a few influential and energetic townsmen and others, constituting the present company, took the matter up. He drew attention to the remarkable rapidity with which electric lighting was coming into favour—only in the last town where he had advised, the number of customers whom he had estimated would be connected up at the expiration of three years' working had been obtained in as many months. He was sanguine that as the light came into more extensive use the cost of production per unit would be very much less than at present—in fact, assuming that the use of electricity became general for lighting and power purposes, he calculated that the cost per unit would be as low as ½d., or equivalent to gas at 6d. It was not at all a certainty that the recent great improvements in the methods of burning gas, and the competition now going on, would not prove in the long run of the greatest assistance to the advancement of electric lighting. For had not the introduction of these improved methods of burning gas demonstrated to the public the advantages of having a beautiful clear light. But a beautiful clear and pure light, without appreciable heat, and no smoke, could only be obtained in the electric light, so that eventually the incandescent gas would, in his opinion, be entirely superseded by the incandescent electric light. He also drew attention to another fact which is sometimes overlooked—viz., the formation of water when a gas-jet is burnt, and the consequent deterioriation of perishable goods in shops owing to the condensation of this moisture on them. This was especially noticeable in cutlers' shops, and cutlers, as a rule, were amongst the first to avail themselves of the advantages which the electric light had over other illuminants. He felt confident, from the good start which had been made, that electric light would prove a success in Shrewsbury.

The CHAIRMAN of the company thanked Mr. Preece for the way in which he had proposed the company. He was rather inclined to criticise the policy of the Corporation in not undertaking the supply of electricity themselves. He instanced many towns in which the electric light was a source of profit to the corporation, and hoped that eventually the Shrewsbury Corporation would see the wisdom of purchasing the undertaking of the company, which he had no reason to doubt would prove a source of income in the hands of the Corporation and a means of lessening the burden on the ratepayers. Meanwhile, rates went up, and regrets were expressed that paying concerns like the waterworks and gasworks were not in the hands of the Corporation.

Mr. W. L. BROWNE proposed the health of "The Consulting Engineer (Mr. A. H. Preece) and Contractors of Works (Messrs. Edmundsons, Limited)."

Mr. A. H. PREECE, A.M.I.C.E., in briefly responding, declared his entire satisfaction at the way in which the whole of the work had been carried out at Shrewsbury. He was sure that the company had got a thoroughly modern and compact little installation, with first-class machinery, mains, etc.

Luncheon over, an inspection was made of the works, the current being switched on to the town circuits by the Deputy Mayor, owing to the unavoidable absence of the Mayor, after which a return was made to the Corn Exchange again, where an electrical exhibition which had been arranged was formally declared open by Mr. W. H. Preece.

THE ELECTRIC LIGHT IN SUNDERLAND.

PROPOSED EXTENSION.

The Electric Lighting Sub-Committee of the Town Council have considered a report from the electrical engineer advocating an extension of the electricity works. The scheme was adopted, the work to be carried out under the initiative of Mr. Brown.

The report submitted by Mr. Brown as to the additional plant required showed that the present plant was divided into two sets. No. 1 can supply (low-tension area) 6,000 lamps, wired, and applications have been received for 6,925 lamps. No. 2 can supply (high-tension) 1,000 lamps, wired, and applications have been received for 600. He proposed an addition to No. 1 system of two dynamos and engines to supply 7,000 lamps wired, or a total of 15,000 lamps in the low-tension area. He did not consider that an extravagant estimate of what the demand was likely to be next winter, considering that within eight months of the station being started the total output had been more than applied for, and it had been the experience of every electricity works so far established that the second year's demand was greater than the first year.

With reference to No. 2 system, he estimated for an engine and dynamo to supply 2,600 lamps wired, feeling sure that this part of the business will grow very quickly, and that many people who have their houses cleaned and repainted in the summer will, on those occasions, instal the electric light. He did not propose that this engine and dynamo should be put down at once, but should be put in the estimate so that the whole loan could be asked for. He also estimated for the approximate amount necessary for additional feeder cables in the low-tension area, as the present feeders are supplying to the extent of two-thirds of their capacity, and also an amount for meters, fuse-boxes, service cables, and small extensions that might have to be made, which should cover the extra customers put on during the ensuing year.

The amount required was £13,750, to which had to be added £2,250 overspent on the original loan due to cables in the residential district, making in all £16,000. Mr. Brown advised, in the event of the Council deciding to memorialise the Local Government Board for this loan, that they should ask that authority to allow the Corporation 30 years instead of 25 in which to repay the loan; and if the Finance Committee could borrow the money at 2¾ per cent. instead of 3 per cent. it would make the difference on 150,000 units (which is practically what this plant could supply) of one fifth of a penny per unit.

When the new plant is in working order, and if the new loan can be obtained on the above terms, the interest and sinking fund charges per unit should not be more than 2d. per unit. In Prof. Kennedy's original report the interest and sinking fund were put at 5¼ per cent., but the Corporation actually pay £5. 14s. 10d. per cent.

When the above extensions have been made, the engineer estimates the cost per Board of Trade unit as 4 20d., and the probable average price obtained per unit as 5d., leaving a profit of 8d. per Board of Trade unit, which on an output of 250,000 units is, roughly, £835. The capital expenditure to September 30, 1895, including all balances retained, is £27,241. 19s. 10d.; the present borrowing powers are equal to £25,000, so that, roughly, some £2,241 have been overspent.

In the course of his report, Mr. Brown stated: "I have further made out a statement showing the probable income and expenditure for the year ending March 31, 1896. The income and expenditure up to September 30 are from actual figures, and the balance is estimated on the results obtained to date; the units sold will certainly be reached, and possibly exceeded, it being impossible to say what will be the actual results, as a dark winter makes a great difference in the output of an electric supply station. (To emphasise this I may say that in the London Electric Supply Corporation the light winter of 1892-3 made a difference of nearly 200,000 units sold as against the previous year, which was very foggy.)

INCOME AND EXPENDITURE.

March 6, 1895, to March 31, 1896.

	£	s.	d.
Estimated expenditure	2,741	19	9
Actual income to September 30, 1895, 19,980 units	£445 4 2		
Miscellaneous revenue	36 19 0		
	482 5 2		
Estimated from October 1, 1895, to March 1, 1896, 60,000 units at 5¼d	1,312 10 0		
Miscellaneous revenue	50 0 0		
	1,844	15	3
Debit balance	897	6	7

"This statement shows a loss of, roughly, £900 on the first year's working, but it must be remembered that only 80,000 units are estimated to be sold, as against what the plant could do—viz, 100,000. If the additional 20,000 units could be obtained the loss would only amount to £450, and if Prof. Kennedy's original estimate of 5¼ per cent. as the annual charge for interest and sinking fund and also his estimated income of 6d. per unit net had been obtained, the loss would have been £75 for the first year."

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CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

STREET-LIGHTING WITH INCANDESCENT LAMPS IN SERIES.

SIR,—As street-lighting with incandescent lamps in series is comparatively unknown in England, a few words as to my experience with this system may interest some of your readers. For some two years I had charge of a municipal electric lighting station in one of the largest of our Colonial cities. Before the introduction of the electric light the streets of the borough were illuminated by 407 gas lamps. These were replaced by the same number of incandescent lamp of 25 c.p. each (of the Thomson-Houston pattern). The lamps were suspended from iron brackets attached to machine-turned poles at a height of 15ft. from the ground, and placed from 40 to 50 yards apart. They were enclosed in clear glass globes made for the purpose, but these were afterwards dispensed with, as they were constantly filling with dust and obscuring much of the light; besides this, they necessitated the employment of an extra hand to keep them clean.

At first some complaints were heard, as many of the ratepayers had expected to see arc lamps erected in place of the gas lamps, but a comparison with the gas lighting in adjoining boroughs was sufficient to convince an unprejudiced person that the electric light (even the despised incandescent lamp) was a decided improvement. Some trouble was experienced at first through having to weed out a number of high-resistance lamps, but this, of course, was not allowed to recur, all lamps used subsequently being tested at the station before they were sent out. Only once during the course of two years have I known the Thomson-Houston short-circuiting device to fail, and this was caused by an inexperienced hand having replaced the ordinary film by a piece of thick paper; but even in this instance the paper broke down after a few minutes, and the circuit was restored before the attendant reached the spot. Indeed, so sure is this device that with only ordinary precautions I would guarantee its perfect reliability. The great enemy to this device is damp, but a carefully constructed shade entirely obviates this danger. At busy corners and cross-roads the ordinary 50-c.p. gas lamps were replaced by three-light fittings. The generators employed were alternate-current machines, giving 100 amperes at 1,000 volts. Thirty-seven or 38 lamps were connected in series in each circuit, there being 11 circuits; the loss of pressure on each varying from 5 to 7½ per cent.

The life and endurance of these lamps is simply remarkable. I have known them last 5,000 hours at normal voltage and even then give a light of 12 c.p. (They were constructed to give 25 c.p. with a current of 3·5 amperes at 25 volts.) At 33 volts they would last from one to three hundred hours, giving a light of from 32 c.p. to 35 c.p. At 50 volts they would last from one to two hours, giving a light of fully 75 c.p. or 80 c.p., a slight variation in the resistance of the filament of course making a perceptible difference in the candle-power.

On the switchboard, line ammeters were connected up in each circuit; failure of a lamp in any circuit being indicated by a slightly higher reading on the ammeter connected therewith. This method is, of course, open to considerable improvement, and it would be an easy matter to make the system more perfect. In one street on the boundary of the borough, where both gas and electric lamps could be seen in direct contrast, the gas company replaced the ordinary burners by Welsbach incandescent gas lamps. This, of course, was a severe trial for the electric incandescent lamps, but the removal of one lamp from the circuit in question, and a slight increase in our working pressure, was sufficient to shame the sickly green light of the opposition.

In conclusion, I believe if this system were given an impartial trial in the hands of competent men it would rapidly find favour in many towns in England for lighting the less important thoroughfares.—Thanking you in anticipation for inserting this, yours, etc.,

HENRY J. SPENCER.

Martin's-chambers, E.C., December 9, 1895.

INSTITUTION OF ELECTRICAL ENGINEERS, Dec. 12.

The annual general meeting of the Institution of Electrical Engineers was held last evening in the hall of the Institution of Civil Engineers, Mr. R. E. Crompton in the chair.

After scrutineers had been appointed for the balloting-list, the **Secretary** read the annual report, from which it appeared that during the year the number of additions to the roll of the Institution was 216, comprising 12 foreign members, 9 members, 108 associates, and 87 students; and 38 candidates had been approved for election. The number of losses by death was larger than last year, but below the average—3 foreign members, 6 members, and 6 associates.

Mr. Crompton moved the adoption of the report, which was seconded by **Prof. Perry**, and carried.

Mr. Raworth complained that the two bodies—the Institution and the Council—were two separate entities, each pursuing their own path. He objected to the term "malcontents" being applied to those members who did not agree with the Council. Gentlemen had found the Council exceedingly difficult to approach. He moved that a special committee be formed to represent the views of the members of the Institution, such committee to consist of Messrs. A. C. Swinton, W. P. Fawcus, A. B. Holmes, A. W. Heaviside, and A. E. Mavor.

A discussion then took place as to the admissibility of this resolution at that juncture without notice; but Mr. Raworth and Prof. Perry were supported by a large number of members in their contention that the second resolution proposed was legal. A heated debate then took place, but the voting was postponed to a special general meeting. The **President**, after the usual votes of thanks to retiring officers, intimated that all the gentlemen on the ballot-list were elected.

The following are the new members also elected:

Foreign Member.—J. S. Rasmussen, Christiania, Norway.

Member.—Albert De Linde, A.M.Inst.C.E, Shanghai.

Associates.—Harry Walton Appleby, 10, Church-street, Durham; Walter Charles Bersey, Grosvenor House, Gore-road, South Hackney; Walter Binns, 128, High-street West, Sunderland; Thomas Blackburn, Barmouth, North Wales; Lionel E. Buckell, 98 and 99, Abbey-street, Dublin; James Watson Christie, 5, Electric-avenue, Brixton; Frederick Byerley Hobler, Rockhampton, Queensland, Australia; Alfred Henrick Jackson, 358, Collins-street, Melbourne; Thomas King, Invicta House, Union-street, Maidstone; Samuel George Maddison, Christchurch, New Zealand; Arthur Pettman Patey, 65, St. James's-road, West Croydon; Arthur Pearson 1, Plimsol-street, Poplar; Thomas Abraham Prout, "Goonvrea," 28, Effingham-road, St. Andrews Park, Bristol.

Students.—Arthur James Abraham, George Berry, John Patrick Clark, Charles F. Dyer. Robert Fleetwood Fuller, Nathaniel Hudson Howard, John Vincent Moinet, William Reginald Potter, Leonard Graham Stanger-Leathes, and John Gillard Stapleton, Faraday House, Charing Cross-road, W.C.; Cecil Barber, Elmfield, South Norwood Park, S.E; Reginald Charles Clinker, 89, Cliftonhill, St. John's Wood, N.W.; Arthur F. R. Curteis, Welby House, The Avenue, St. Margarets; W. E. Ferguson, 9, Brunswick-square, W.C.; Herbert Douglas Hodges, 28, Larkhall-rise, Clapham, S.W.; Sydney George Redman, 60, King's-road, Chelsea, S.W.; Charles Renton, Eastern Telegraph Company; John C. Vaughan, Wraxall, near Bristol.

WHAT, WHEN, AND WHERE.

Society of Arts.

December 16, 8 p.m.—Cantor Lectures, "Mechanical Road Carriages," by W. Worby Beaumont, M.I.C.E. Lecture III.

December 17 4.30 p.m.—Foreign and Colonial Section. "Jamaica in the Past and Present," by Frank Cundall.

Royal Meteorological Society.

December 18, 7 30 p.m.—At 25, Great George-street Westminster. Ordinary meeting. "Notes on Some of the Differences between Fogs, as related to the Weather Systems which accompany them," by Robert H. Scott, M.A., F.R.S. "Analysis of Greenwich Barometrical Observations from 1879 to 1890, with Special Reference to the Declination of the Sun and Moon," by Major H. E. Rawson, R.E., F.R Met Soc. "Meteorological Observations taken at Mojanga, Madagascar," by Stratton C. Knott, F.R.Met.Soc.

Institution of Civil Engineers.

December 17, 8 p.m.—Ordinary meeting. "The Design and Testing of Centrifugal Fans," by Hammersley Heenan, M.I.C.E., and William Gilbert, Wh.Sc., A.M.I.C.E.

North-East Coast Institution of Engineers and Shipbuilders.

December 17, 7.40 p.m.—At the Lecture-hall of the Subscription Literary Society, Fawcett street, Sunderland. Third general meeting. 1. Minutes of last general meeting. 2. Ballot for new members. 3. The discussion on W. Cross's paper on the "Surface Condensing Plant at the Newcastle and District Company's Electric Works, Forth Banks, Newcastle-on-Tyne," will be resumed. 4. The discussion on J. Denholm Young's paper on the "Application of the Law of Similarity of Marine Propellers," will be resumed. 5. Paper on "An Investigation into the Forces Tending to Produce Vibration in High-Speed Engines," by J. M. Allan. 6. Discussion.

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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VOTE OR NO VOTE.

We can commend the *Journal of Gas Lighting* for again calling attention to the right of gas shareholders to vote upon electric lighting questions. Speaking solely from the standpoint of electric lighting interests, we ought perhaps to feel grateful that the great legal luminaries who have been consulted on the subject have in the majority of cases decided against the validity of gas shareholders voting. Of course, the *Journal* in its crusade against electric lighting would prefer the votes of the gas shareholders, and, strange as it may appear, we should prefer them to give their votes. It is assumed that because a man is interested in gasworks he is unable to give an independent vote at the council table. It is assumed that each gas shareholder has so great a pecuniary interest in gas that he will not jeopardise his income, or a part of it, by voting against gas. Is not this view a modern English view, and against the spirit of the nation? Do we not boast that a man is held to be innocent till he is proved guilty? Why should we assume that a man elected to serve the interests of his town should put his own interests first, and be unable to give an honest opinion? Under existing circumstances, if a number of the members of the local authority hold only one share each in the gasworks, they are interested, and held to be unable to vote upon an electric lighting question. There are black sheep everywhere, and no doubt if all votes were taken the electric light would, for the moment, be lost to some towns; but we do not believe the evil would be of long duration. At an early election the question would be made a test one, and the candidates would either have to agree to what their constituents required or give place to other men. We assume that in the majority of cases the constituents do want the electric light. We cannot assume aught else, because its superiority to all present competitors is overwhelmingly great. We cannot for one moment consent to believe that the future of electric lighting would be jeopardised by the voting of all the men on a council. Who have in many instances been the leading men to the introduction of electric lighting? In Bradford, if we mistake not, the leading spirit was the chairman of the Gas Committee. He was perhaps not interested in the same way as a gas shareholder might be interested, but we may take it for granted that he would not risk his reputation as the chairman of a prosperous town gasworks by the introduction of a competitor that would ultimately destroy the gasworks. He must have been convinced as to the superiority and inevitableness of electricity before urging his colleagues to adopt it. Look, again, at Leicester. Here we find the manager of the gasworks designing an electric light station. His interest, again, was not that of a gas shareholder, but surely his interest was to get the best return from the works in his charge, and he would not be likely to take up *con amore* an opposition works without he saw that the change must come, and preferred it in his own hands than in the hands of an outsider. Plenty of other cases might be cited where it would

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at first sight be thought that the interest of the man was overwhelmingly in one direction, yet we see him earnestly advocating action in another direction.

Our view of local authorities is that the members are elected to do the best for their constituents, and that the holding of one, two, or ten shares, or a directorship, in a company is not a sufficient inducement to make the majority unfit to enquire into the merits of some scheme that will compete with the one in which they are shareholders. We imagine that the fear of rejection at the polls would be a stronger incentive to act in the direction of the wishes of their constituents than the pecuniary question would be to act against it. If the general public do not want the electric light, the difficulties in the way of its adoption will be far, far greater than if the constituents want it and a few gas shareholders don't. We do not believe there is a constituency in the United Kingdom but would, if the question of gas or electricity be properly brought before them, decide in favour of the latter, and where this is done the opposition of gas shareholders is but a small matter, and will soon be brushed aside.

CONCENTRIC WIRING.*

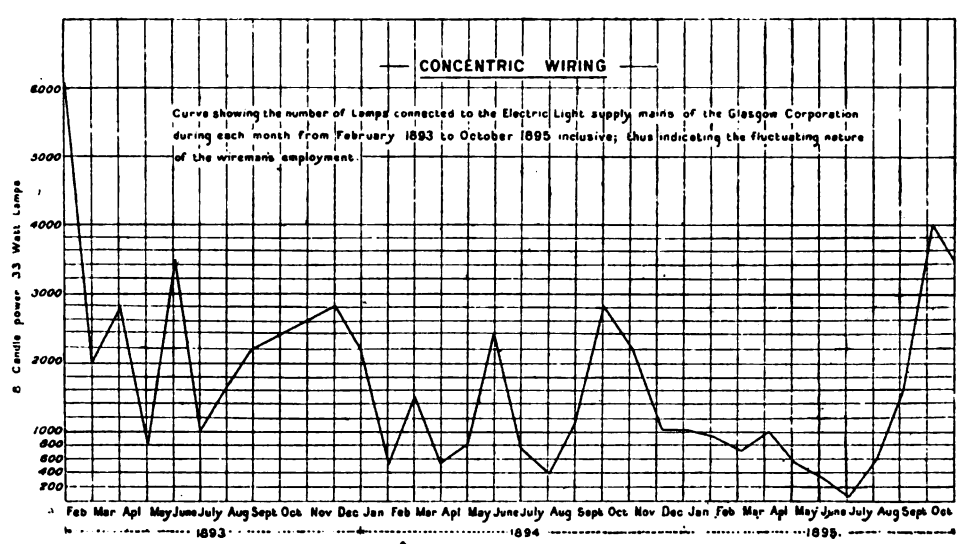
BY SAM. MAVOR, MEMBER.

Considering the importance of the subject of electric light wiring, it does not seem to have had an adequate share of the attention of this Institution. This is the more unfortunate as the tendency now is to allow the business of wiring to drift out of the hands of experienced electrical engineers into the hands of the legion of plumbers, gasfitters, and others who, often with small claim to the title, write "electrical engineer" upon their signboards. It is inevitable that wiring shall fall more and more into the hands of tradesmen of this class. They will follow more or less closely the methods of their predecessors, by a highly-trained and skilled tradesman. For such work as the mason's, the bricklayer's, the joiner's, cabinetmaker's, etc., a man requires the training of a long apprenticeship, which entitles him to the wages of a skilled craftsman, but the mere laying of wires already manufactured in grooved wood casings erected by a joiner, and fixing ready-made switches on bases also prepared by the joiner, do not require the serving of a long and laborious apprenticeship. On the contrary, any man who can use his hands may, with very short experience, learn to joint wires and fix switches and then call himself a wireman. The inevitable result is that such labour can, and always will, be cheaply purchased. Much wiring work is really done by irresponsible amateurs of this kind, who are ignorant of the consequences which might result from their carelessness or lack of experience.

A further reason why electric light wiring is often not carried out by first-class labour lies in the intermittent nature of the employment. There are certain seasons of the year when the wiring contractor has little of such work, and must then discharge men. Indeed, wiremen are many times taken on at the beginning of a job and paid off at the end of it. Workmen of skill and intelligence soon find this out, and they seek employment in branches of the business where their qualifications find a better and more steady market. We all know how demoralising it is for men to be idle for months at a time, and how apt they are to drift into lazy and careless habits. The accompanying diagram shows the number of 8-c.p. lamps connected to the Glasgow Corporation mains during each month from January, 1893, till the present time. The curve illustrates the fluctuations in the demand for wiring, and you will see that the wireman's load-factor is decidedly unsatisfactory.

You cannot expect a man to have a thorough interest and sense of responsibility in his work who knows that he will be paid off at the completion of the job. As wiring jobs often last only a few weeks, the poor wireman may have been in the employment of half-a-dozen masters in the course of a season, with intervals of enforced idleness. In the case of joiners and plumbers and kindred trades, when outside work is slack, the men may be employed in the shop at preparing material or in manufacturing; but not so with the wireman. The material is all already prepared for him by skilled hands—his business is only to erect it. The larger firms who have a variety of electrical work can find employment for the best of their wiremen in other branches when internal wiring is dull. But they, too, when business is brisk, have to fall back upon the shiftless creatures who often present themselves as "wiremen." The proportion of "improvers" and apprentices employed at wiring is very much larger than in any similar trade.

The business—if it may be called a business—of electric light wiring has thus several features peculiar to it making for


CONCENTRIC WIRING
Curve showing the number of Lamps connected to the Electric Light supply mains of the Glasgow Corporation during each month from February 1893 to October 1895 inclusive; thus indicating the fluctuating nature of the wireman's employment.
8 Candle power 33 Watt Lamps
6000
5000
4000
3000
2000
1000
800
600
400
200
Feb Mar Apl May June July Aug Sept Oct Nov Dec Jan Feb Mar Apl May June July Aug Sept Oct Nov Dec Jan Feb Mar Apl May June July Aug Sept Oct
1893
1894
1895

and defects in existing practice will thus be widely propagated. This is a question which seriously affects the whole industry, and hence the importance of this Institution setting an example by aiming at and endeavouring to secure a high standard of excellence in wiring work. It is a characteristic of the business of electric light wiring that it is peculiarly liable to the risks attending bad workmanship. Internal wiring—that is, the laying of insulated conductors in grooved wood casings, the jointing of these conductors, and the fixing of switches, fuses, etc.—is a comparatively simple matter. Apart from the distribution of lights and arranging the circuits and their routes, it is not work which must necessarily be done unreliable workmanship, which, in the absence of competent supervision and careful inspection, lead to defective work and resulting fire risk.

The plumber's and the gasfitter's work are to a great extent self-testing. If a water-pipe leaks we see the water, and if a gas-pipe leaks we usually smell the gas; but we have no sense—no physiological sense—to enable us to find hidden defects in our electric wiring. A building may be wired in the most dangerously slipshod style, yet the lamps may for years burn none the less brightly, until the latent faults have opportunity to discover themselves.

Insulation tests after the completion of the work, if in dry and well-seasoned buildings, are of little value. The insulation tests of the wiring of an old building might show results three or four times higher than the most stringent rules require, and

* Paper read before the Institution of Electrical Engineers, November 28.

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yet there might be a score of dangerous defects only awaiting opportunity to develop. No tests can be applied for the detection of these defects after the work is completed and covered in. On the other hand, in a new and damp building the insulation might be far below the requirements of the rules, and yet be absolutely safe. The important thing is that the work shall be carried out in such a style that the insulation attained shall be permanent, and tend to increase, rather than decrease, with time. Wiring has to be carried out in situations so different, and must comply with conditions so varied, that it is impossible to formulate rules which can in all cases be adhered to. Modifications must be allowed to meet special requirements, and the extent of these must be left to a great extent to the discretion of the contractor. That such discretion ranges over very wide latitudes is indicated by the large discrepancies between the tenders of different contractors for the same wiring work. When the prices of experienced contractors estimating for wiring work to a carefully drawn up specification vary as we know they do, it is not strange that inexperienced contractors tendering in the absence of a specification, and without the prospect of any supervision, should quote prices which would not purchase suitable materials alone. These are matters of primary importance to the fire insurance companies, and they are much too lax in looking to their interests in this regard. Bad work is being carried out every day, and the insurance companies are complacently taking the risk. Several offices have issued wiring rules, and it is a very good thing for them to have rules; but what is the use of rules if they are not enforced? At present they are really only recommendations, and anyone who is so inclined may evade or ignore them. It is common knowledge that this is constantly done.

The present procedure of the insurance companies is most ingenuous. They send a schedule to the contractor who is carrying out the work—or, rather, who has done the work, for it generally arrives after the job is completed—and they then request the contractor to oblige them by giving replies to a list of questions. They receive the document filled up by the contractor, who has no responsibility beyond a moral one, and file it away, and presumably are satisfied that the thing is all right. They thereby exhibit a trust in human nature very flattering to the wiring contractor, but of the wisdom of which some of us may have our doubts. Until the insurance companies have organised a thorough system of inspection they will not have taken the steps necessary for their own protection. It seems to me that in every considerable town there ought to be a permanent official (in the pay of the fire offices collectively) whose duty it would be to inspect all electric light wiring while in course of erection, and to ruthlessly condemn defective workmanship or material. If such a staff of well-chosen, reliable, and sufficiently well-paid inspectors were scattered over the country, they would soon put a stop to jerry work. The moral influence of their presence in the town would be a wholesome check upon the cheap jack. The cost when spread over all the companies would be trifling, and would be amply repaid by the reduction of fire risk. The insurance companies already have one man in their collective employment in each of several of the larger cities. This man is an *attaché* of the Salvage Corps, and his duties are confined to the warehouse district. His functions are to familiarise himself with the positions of main switches, fuses, and cables, etc., in the warehouses, with a view to his being of service to the fire brigade in case of emergency.

Before leaving this subject it may be noted that Lloyd's Register of Shipping some years ago issued a set of recommendations for the guidance of shipbuilders and owners in fitting electric light on their vessels; but as they took no steps to ensure that effect was given to their suggestions these remained a dead letter. The large number of electric fires on board ship during recent years, chiefly due to inferior work resulting from the practice of accepting the lowest tender, has impressed upon Lloyd's the imperative necessity for supervision. They have, therefore, issued a new set of rules, and they are now arranging for such a system of inspection as will ensure these rules being followed. The fire insurance companies would do well to profit by the dearly-bought experience of Lloyd's. If they do not, they will assuredly have to learn the lesson at their own expense. Although the insurance companies are primarily interested in this question of fire risk, the matter has a direct and important bearing upon the electric lighting industry. We must all recognise the desirableness of ensuring that wiring shall be carried out in a style which shall be fireproof, electrically and mechanically good and durable, and shall not be offensive to the eye.

There is a steadily-growing dissatisfaction with the generally-adopted practice of enclosing the conductors in wood casings, and a steadily-growing conviction that something better might be done. In most factories and warehouses it is possible to have the casings laid upon the surface, but in dwelling-houses or in good hotels or clubs it should not be tolerated. Everyone is familiar with the unsightly wood cases and clumsy crockery ware which disfigure so many of the best hotels and other buildings in this country. How often we hear that electric light is not adopted because of the dread of the wood casings, and the cutting about and disturbance which their erection involves! Those casings are a standing reproach to the people who erect them. One has only to see the interior of a good building which a contractor has dared to wire on the prescribed lines with wood casing to realise how utterly unsatisfactory is the system. Those hideous casings are entirely out of harmony with their surroundings, and offend the eye at every turn. They blunder across ceilings and cornices, intrude upon decorative panels, and push their ruthless way through frieze and dado; while out of sight beneath the floors the joists are cut away to clear the casings until the margin of strength is often perilously low. The truth of the matter—and we all know it—is that we cannot carry out the wiring of, for example, a private residence in compliance with the recognised rules for double wiring and wood casing without excessive cutting of floors and plaster work, and disfigurement of walls and ceilings. At every turn we have to compromise between the decorations of the house and the fire insurance rules, and the concession must needs be generally in favour of the decorations. In short, the modifications of the rules require to be so many and important that this system of wood casing is one which cannot be consistently and thoroughly carried out.

When the usual double wiring is carried out in situations where moisture charged with acid from cemented or plastered walls of interiors, or in such buildings as paper-mills, wet spinning mills, dye-houses, breweries, distilleries, chemical works, and the like, the destruction of the insulation is only a matter of time, and the casing, by harbouring the moisture around the conductors, hastens the process. After the insulation has broken down, electrolysis, assisted by the acidulated moisture, takes place, and deposits away the copper of one of the conductors, with the consequent risk of heating, and ultimately of sparking. The presence of moisture being a necessary condition of the development of such faults, the dampness of the surroundings of the conductors greatly reduces the danger of fire, but that the risk is not absent is proved by the charred and burned casing or woodwork found at such places. It must be remembered, however, that heating due to diminished section of the conductor may occur at a time when the moisture which caused the fault has disappeared, and this is a danger which no amount of fuses will modify. How can you ensure that your wood-cased conductors shall never be subjected to such conditions? And how many of your average wireman's joints would stand 24 hours' immersion in water or soaking in moisture? The miserably futile expedient of attempting to waterproof the casings with putty and varnish is sometimes resorted to; such makeshifts are too childish. Lead-covered conductors are occasionally used where much moisture has to be encountered. But these for double wiring are a mistake, unless the positive and negative wires are both enclosed in the same lead sheathing. The objection to separate lead-covered conductors is that if there should be an earth or leak on the negative wire, and the lead and insulation of the positive wire becomes punctured at a damp situation, the lead becomes charged positively, and will be deposited away over its whole length where moisture is present to assist electrolysis. This remark has no application to lead-covered conductors on board ship, where the lead sheathing is throughout in intimate contact with the hull of the ship, nor to lead-covered concentric conductors. This liability to injury from moisture is the fatal weakness of the ordinary wood-cased system. It is of much greater consequence to obtain a moderately high insulation which may be relied upon to be durable, than to have—as can easily be had in a dry building—an insulation resistance of many megohms which will disappear on the approach of the charwoman and her wash-bucket, or is at the mercy of the first loose slate or leaky water-pipe. What a common experience it is to discover wiring faults in the fungus-grown casings in damp and mouldy basements, or upon the "sweating" surfaces of cemented walls or ceilings! A fault which developed a few weeks ago in the writer's office is a good illustration of the weakness of the present double-wiring practice. The walls are covered with a light-green paper, which on one side of the room is pasted to a wooden partition, and through this partition and paper the conductors are led to a switch. Behind the base of this switch sparking was observed. On examination it was found that in our humid climate the paper had absorbed moisture from the atmosphere, and this moisture, charged with an acid held in the paper, had attacked and destroyed, first the insulation of the conductors, and then the copper, until of the latter only a green sulphate remained, and the circuit was interrupted. As only one lamp was in circuit the spark was small and the heating effect slight, but under other conditions the results might have been serious. This is an interesting example of a fault developing in an apparently dry and well aired and warmed room, and under the eyes of one whose business it is to avoid such faults, and to whom a spark was the first intimation of anything being wrong.

After wood casing, with its perviousness to moisture and other

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attendant disadvantages, the biggest blot on existing practice is the indiscriminate use of fuses. Some insurance people and wiring contractors, too, imagine that the risk of fire varies inversely as the number of fuses. The contrary is more near the truth. Fuses are not only a nuisance, they are apt to be a positive source of danger. The smaller number of fuses used the better; but they must be absolutely reliable, well mounted, and well placed. Most of the leading wiring contractors have adopted the distributing-box plan of wiring, in which the branch fuses are grouped at the distributing centres. This system should now be compulsory. The use of isolated fuses should be strictly prohibited. The only inducement to use them is a trifling saving in the cost of conductors. The number of fuses should be kept down by keeping up the section of conductors. The larger expenditure on branch conductors entailed is amply repaid by the simplicity and uniformity secured. The dangers of diminishing the section of conductors and scattering fuses through a building are that the crockery fuse bases and cases are liable to breakage; the terminal screws are liable to become loose, and so cause heating; and last, but most important, the danger of a conductor of too large area being used by an inexperienced or careless person instead of a *bonâ fide* fuse, in which case the "fuse" is a delusion. This last danger is so real and so imminent that the insurance companies ought long ago to have prohibited the use of such fuses. The writer was recently in competition with a firm of contractors of large experience who do a great amount of wiring, and were in this case estimating for wiring about 200 lamps of 16 c.p. each. Samples of the conductors, etc., quoted for were invited along with the estimates, and our double-wiring friends submitted a sample of each of the nine sizes of insulated cables and wires, with their corresponding wood casings, and of each of the several sizes of fuses which they proposed to use. Nine different sizes of cables and wires were certainly not essential to the double wiring of this building, but they were part of the method of a much-experienced contractor, and his method is common to many others.

Switches have been greatly improved during the last few years, both in mechanical design and in external form. The clumsy switches, with the ugliness of their porcelain covers embellished by gilt lines or floral decorations, have now nearly disappeared. They are superseded by switches of neat appearance, with suitable metal covers. The working parts of the switches are of a much more mechanical type than formerly, but there still remains ample room for improvement. There are far too many parts, too many screws, and too many contacts. The practice of dispensing with binding screws and soldering the wires directly to the contact-plates should be highly commended. How often one sees the attempt made to secure the ends of conductors—frequently of considerable size—under paltry little cheese or round headed screws and washers absurdly too light and inadequate to the purpose!

The ceiling-rose is also a weak spot in double wiring. There are far too many contacts in it. To begin with, there is the usual crockery base, and upon this base are three little brass plates, with twice that number of brass screws. Each of these six little screws binds to a contact the end of a conductor or fuse, and every screw of them is liable to become loose, and every contact to become oxidised. Where vibration or moisture are present the development of trouble is only a question of time. Do those who so freely erect these little collections of screws and contacts ever consider the harvest of petty troubles and annoyances which will be reaped by-and-by?

We must now pursue our painful path of adverse criticism to the lamp-holder. The double-contact lamp-holder, especially when attached to flexible pendants, is the frequent seat of short-circuit and minor troubles. In this little piece of apparatus there are two contact-plates, carrying the buffer springs and the inevitable binding screws. Each of these contact-plates must be insulated from the other, and both from the surrounding metal tube. When this is done, small space remains for further intrusion. But the flexible conductors are still to be brought in and pinched under the binding screws. Stray strands from these flexibles, where they are not most carefully soldered, are frequently responsible for short-circuits and the melting of many fuses. The risk would be reduced if here also binding screws were dispensed with and the wires brought straight through the insulating disc into holes in the plates and soldered therein.

It is with a sense of relief that one turns from double wiring and all its attendant ills to the simple mechanical and straightforward methods of concentric wiring with an uninsulated outer conductor. So far as the writer is aware, no system of concentric wiring in which both the inner and outer conductors are insulated has ever been used for indoor work. It appears probable that the difficulties in the way of designing junctions, switches, and other accessories which shall meet the electrical and mechanical requirements within moderate dimensions and at reasonable cost, will prevent the introduction of such a system. Two and three wire concentric cables with each conductor insulated are largely used as mains in connection with two and three wire systems, but in such cases there is no difficulty in providing junction-boxes of adequate size. The only system of concentric wiring which has been adopted for internal use has an uninsulated outer conductor, and it is this system that is known as "concentric wiring." It is important that it be clearly understood that concentric wiring is not "single wiring," but is something essentially different. This distinction between concentric wiring and single wiring is necessary, because the two have been frequently confused. No method of wiring merits the title "concentric" which is not consistently concentric throughout. In a concentric system the central conductor must be everywhere surrounded over its insulation by a metallic sheathing of conductivity equal to or greater than the core. The switches and fuses should be in the central wire and enclosed in metal cases. These cases or boxes should be electrically and mechanically jointed to the outer conductor, and so form part of the continuous metallic envelope in which the central conductor is enclosed.

It must be pointed out here that, under the existing Board of Trade regulations referring to the insulation of electric light supply mains, concentric wiring is not admissible where connection has to be made to a source of public supply in this country. This is a matter to which we shall recur, and shall meanwhile consider the question of concentric wiring with regard to installations supplied with current from independent plants. The adoption of concentric wiring is the royal road out of the difficulties and dangers which beset double wiring. It seems to be difficult for those who have been accustomed to devote so much pains to attain good insulation of both conductors to realise that there is no necessity for doing so. The adoption of concentric wiring dispenses with this necessity, and abolishes risks which make a high standard of insulation of both conductors in a two-wire system so desirable. Much misunderstanding and prejudice, due to lack of information, exist with regard to concentric wiring; but there is complete absence of valid objections to its use, and prejudice against it is soon dissolved by an acquaintance with the system.

Some of the fire insurance companies were at one time rather suspicious of concentric wiring, probably because they feared its adoption would lead to the abolishing of their cherished rules regarding the width of fillets in wood casing, etc. The insurance companies are, however, now unanimous in their favourable verdict on the subject, and have recognised the advantages of concentric wiring from their point of view. More extended experience and appreciation of its fireproof qualities must confirm the preference many of them now have for concentric wiring.

It has been stated that, owing to one conductor being already earthed, the liability to complete breakdown of the insulation is doubled. This might be true of double wiring, but is certainly not true of concentric. The outer conductor being already at earth potential, there cannot be any risk whatever of shock or spark being experienced from it. There is thus only one vulnerable conductor, and this, with its insulation being encased throughout its entire length in the metallic sheathing formed by the outer conductor, is well protected against injury. The consequences of injury to concentric and to double wiring are essentially different. In the case of the concentric conductor, if it should be crushed or a nail be driven into it, the instantaneous result is a dead short-circuit and the melting of the fuse. If the insulation should be punctured and moisture gain access, the distance across the insulation between the conductors is so small that the fault immediately develops into a short-circuit, and the spark passes from the centre conductor to the inner surface of the metallic sheathing, and being entirely within the sheathing it cannot communicate fire to its surroundings. Concentric conductors are thus self-testing. Faults cannot endure. They cut themselves out automatically. Or, rather, this is what they would do if faults were experienced, but we never have faults in lead-covered concentric conductors. How different is the case of ordinary double-wire conductors laid in the separate grooves of a wood casing! The casing which is provided for mechanical protection may become a positive source of danger, and may be ignited by leakage across the fillet—a danger which the fuse is powerless to prevent. In concentric wiring there is only one cable to handle instead of two, and this carrying its own protection the necessity for wood casing is abolished.

Perhaps the most conspicuous advantage of concentric wiring is that it may be so easily and so effectually made waterproof. The cables may be enclosed in lead sheathing laid under or over the outer conductor, and hermetically sealed to the various apparatus into which the cables are led. This must appeal to all those who have had a varied experience of wiring. If moisture—the arch enemy of good insulation—can be permanently excluded, it means the permanent maintenance of a high standard of insulation, and consequent freedom from trouble.

The next important advantage to be claimed is the large reduction in the number of fuses. The drastic method of abolishing fuses is to maintain the section of the conductors. This can readily be done in concentric wiring to an extent impracticable in double wiring. Conductors of much larger

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section may be conveniently and safely led into C.C. lamp-holders, ceiling roses, and wall sockets, than is possible in double wiring. And thus, by maintaining the section of conductors right into the lamp-holders, many of the objectionable fuses are abolished. The fuses when reduced in number are more easily centralised and arranged in groups of standard size. It may be objected that if the number of fuses is diminshed a larger number of lamps are affected in the event of a fuse being melted by a short-circuit. This is a very natural objection for one experienced in double wiring to offer. But it has no application to concentric wiring. We never have short-circuits. It is in double-contact lamp-holders, and double-wire flexibles, ceiling roses, and the like, that short-circuits occur. Compare a central-contact and a double-contact lamp-holder. A 7/16 concentric cable may be led into the former more easily, and with greater safety, than two single No. 16 L.S.G. wires or their equivalent can be led into the latter. It is not necessary to lead 7/16 cables into concentric lamp-holders, but the possibility suggests the large margin of safety in favour of the C.C. holders. The difficulty of avoiding mishaps in double-wire lamp-holders will be emphasised by the introduction of 200-volt lamps. While on the subject of lamp-holders, it may be noted that, there being only one buffer spring in the C.C. lamp-holder, and that exactly in the centre, there is less risk of twisting lamps out of their collars while inserting or removing them. Concentric lamp-holders, ceiling roses, and such fittings, having only one—and that a central—contact to be insulated, may be made of better mechanical design than where within the same space two contacts have to be insulated, each from the other, and both from the containing case. The benefit of the great reduction in the number of parts can hardly be exaggerated, the liability to derangement is so very greatly reduced.

In regard to fittings, the comparison is again in favour of concentric wiring. The flexible conductors of which the pendants are made are of such large section that they are mechanically strong. The pendant terminates at either end in a screwed brass nipple with insulating plug and central contact—an arrangement which is substantial without being clumsy. No loose strands are possible. The top nipple of the pendant is screwed into the junction or fitting base, and the nipple at the lower end is screwed into the lamp-holder. The brackets are similarly wired to screwed nipples with central contacts. The erection of fittings is therefore an extremely simple operation, and the labour so employed is reduced to a minimum.

The method of concentric wiring illustrated by the patterns before you is based upon a full recognition of the fact that electric light wiring, in order to be permanently durable and reliable, must be impervious to moisture. So far as the writer is aware, this is the only method of wiring which provides a continuously waterproof metallic sheathing over the insulation from the main switchboard to the lamp-holders. The main switchboard has the usual single-pole switch and fuse arrangement, and the board is surrounded by the negative omnibus bar, which receives in sockets attached to it the outer conductors and sheathings of the concentric cables. The main cables—which are lead-sheathed throughout, and are generally armoured with galvanised iron wires laid over the lead on a cushion of jute—are carried without break or joint direct to their respective distributing-boxes, where the central conductors are soldered to the omnibus bars, and the outer conductors terminate in gunmetal sockets secured to the boxes. The distributing-boxes are of cast iron or cast brass, enamelled white inside, and fitted with fuses, or switches and fuses, as required. These boxes have close backs and hinged fronts closing upon an indiarubber ring, thus rendering them proof against dust or moisture. The concentric branch cables which radiate from these boxes are under all ordinary circumstances of uniform section—namely, 7/21½—equal in area to 0·005 square inch. The outer conductor of the cable has the same section of copper as the core, and the whole is enclosed in a solid-drawn tube of lead. Wherever a joint is to be made, or the cable led into a switch or fitting base, the centre wire is soldered to its contacts, and the outer conductor and its lead sheathing are received and terminate in a jointing pocket cast upon the switch-box or junction. The central wire and its insulation are thus enclosed throughout their length in a hermetically-sealed metallic sheathing. The section of the branch conductor 0·005 square inch is carried into every switch and into every lamp-holder, no reduction being made. There is no necessity for any fuses other than those in the cast-iron fuse-boxes, and these are all uniform and interchangeable. It is very rarely that occasion requires any departure from this plan. Many large installations have been carried out on the lines indicated, some of these amounting to several thousands of lamps, where only two sizes of fuses—main and branch, respectively uniform and interchangeable—have been used. The simplicity and reliability of such a system must be too obvious for emphasis.

The branch cables are led through buildings like flexible gas-pipes, but they are not liable to damage as composition gas-pipes are. The conductors and the insulation within the lead sheathing serve as a backing for the lead, so that it is not at all easily damaged. It has been the custom of the writer's firm for years to have their concentric conductors and joints embedded in the plaster of new buildings, and they never known a single instance of a fault developing in conductors so treated. It is sometimes objected that where the conductors are so buried they are not accessible. They certainly are not. Why should they be? It is essential that wood casings carrying ordinary double wiring should be accessible; further, it is desirable that they should be visible wherever possible. But the conditions with regard to lead-covered concentric conductors are entirely different. Given a conductor and joint of imperishable materials, and impervious to moisture and the acids found in plaster and cement, and no reason remains for laying conductors on the surface, or of providing access to them where enclosed in plaster. This demand for accessibility, and the objection to cover conductors with plaster, is a relic of the times when indiarubber-covered conductors laid in wood casing were embedded in walls. The bitter experience which rapidly follows this practice results in the prejudice against covering any conductors with plaster. If anyone wishes to have his conductors laid on the surface of plastered walls by all means let him do so, but there is no necessity either to lay them on the surface or to provide access to them where lead-covered concentric conductors are used. Access to the distributing-boxes only is necessary.

Another bogey is the chance nail driven into the plaster. Consider how largely the practice of embedding composition gas-pipes in plaster is in vogue, and how immeasurably greater is the danger resulting from the piercing of such a pipe than from piercing the insulation of a conductor! Yet how seldom one hears any objection to the practice. If a nail is driven into a concentric conductor the immediate result is an emphatic short-circuit, and the fuse melts: there is not the slightest danger. Two cases only of nails piercing embedded conductors have come under the writer's notice. Both of these were in the same building—a block wired for about 500 lights, where all the conductors were embedded in plaster. The faults—one behind a picture moulding, and the other behind a dado—were readily localised and repaired before the work was completed.

The insulation resistance of the wiring in a new building is not a matter which causes any anxiety. The lead sheathings and brass junctions and switch-boxes make one independent in this regard. In occupied buildings the lead-covered branch conductors may be led about under floors and behind plaster and linings with the greatest freedom and complete immunity from danger. The amount of lifting of flooring and disturbance to woodwork and plaster is only a fraction of that required for the carrying out of wood-cased double wiring.

The junctions employed, specimens of which are upon the table, may be manipulated by an intelligent man who can use a soldering bolt. No careful lapping of insulating material around the joint is required. The insulation is air space, and there is none better. The branch conductors being of uniform size—so are the junctions—men soon become expert in jointing. The operation is so very simple and easily performed that it may safely be done by unskilled labour. This feature specially adapts the system for export. As an illustration, it may be stated that a squad of Hindoos, chiefly tinsmiths, under the guidance of one European, carried out in the most satisfactory style the wiring for 3,000 lamps in 10 weeks.

In mills or factories floored with wood the conductors are cleated to the woodwork with brass cleats: and where iron beams and concrete floors are met, the conductors, with junctions (tapped to receive the pendants) attached at the proper intervals, are secured by brass or copper cleats to stranded steel suspending wires strained between eye-bolts attached to the walls. The laborious plugging of the concrete ceilings, with the resulting dust and disturbance to the factory and expense to the wiring contractor, is entirely abolished. In single-storey weaving sheds, ironworks, or other buildings with iron roofs divided into bays, the same method of suspending the conductors between the beams or tie-rods is adopted.

In support of the claim that this method of wiring is reliably waterproof, the case of Messrs. Nobel's Explosives Company's West Quarter Factory may be cited. The buildings to be lighted are isolated and scattered over a large area in order to reduce the risk and minimise the effect of explosions. The regulations issued by the Home Office regarding electric lighting were so very stringent that it was impracticable to comply with them except by the use of concentric wiring. With concentric wiring everything was made easy. Its waterproof and fireproof properties overcame all the difficulties. Every joint and every yard of the conductors is outside and exposed to weather, cleated for the most part to the gangways. The switches, of cast brass, and distributing-boxes, of cast iron, are also all outside, protected only by water-sheds. The work of wiring was completed more than three years ago, and, notwithstanding three years' exposure to the elements in this climate, the insulation resistance is as high as ever. Monthly

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tests of the insulation are required by the Home Office, and on the 10th of last month the insulation resistance was two and a half times higher than the most stringent of the fire office rules require for indoor wiring. In the nitrating department of the same factory, which is a quarter of a mile distant from the other installation, the insulation is equally satisfactory, although the wiring is subjected to the profuse fumes of nitric acid. It is noteworthy that the insulation of the wiring at both these places is not indiarubber, but is fibrous. The exclusion of moisture is therefore solely due to the lead sheathing and waterproof nature of the joints.

The more difficult the wiring of a building appears to be, the more favourable is the comparison to concentric wiring. The iron roofs, concrete floors, moisture, and other ills that vex the spirit of the double-wirer have no terrors for his concentric friend. For wiring in any situation—from collieries to boudoirs, where difficulties of erection have to be faced, or in situations where the conductors, etc., after erection must endure excessive heat or cold, moisture, acid vapour, or inflammable dust—concentric wiring meets the case. Conviction of its immense superiority is immediately impressed by inspection of buildings so wired. The thing requires to be seen to be appreciated. Concentric wiring has this further advantage—that a very simple and easily followed set of rules can be framed which are applicable to wiring to be carried out under widely differing conditions.

Contractors who are unacquainted with concentric wiring are often ready, when they know it is in competition with their double-wire tenders, to pour into the ears of their prospective client a dismal tale of the woes which follow the adoption of any system which would not embrace their precious wood casing and crockeryware. If those contractors were informed on the subject, they would learn how great is their error. Take a contractor who has had experience of concentric wiring into any building whatever, and he will show how to make a better, more mechanical, reliable, and durable job, and generally at less cost, than is possible with double wiring. Those who have used only double wiring, and know no other, are reluctant, and with reason, to depart from practice in which their patterns are systematised and standardised, and in which their staff are trained. But when the change proposed is all in the direct on of simplicity and reduction of labour, the chief objections to its adoption are removed. That fires or minor troubles are not more frequent in badly-wired buildings is a fine testimonial to the safety of electric light wiring, but is no excuse for the continuance of slipshod work or adherence to existing methods where improvements are possible.

For mining work concentric wiring is specially adapted. The mechanical nature of the fittings and the ease with which they and the conductors may be made waterproof are important features. A concentric cable for mining purposes is more safe than two separate cables. A fall of material from the roof may rupture one of two conductors, and if current is passing the inevitable result is a spark at the point of parting. In fiery mines this might have serious consequences. With a concentric conductor, however, the fall would crush the outer conductor in upon the core, and so cause a dead short-circuit and melt the fuse before the cable parted. The spark would thus take place at the fuse at the pit bank. In the only case of such accident within the writer's experience the fuse did promptly melt. Several devices have been proposed for the purpose of preventing a spark at the point of rupture of cables used in pit work. There is room for doubt as to the likelihood of these devices performing their functions in case of need. There can be no question that the concentric cable is much more simple, and it is probably more reliable than any of them. Further, none of these arrangements afford to the miner the immunity from personal danger from shock which the concentric cable does.

An E.M.F. of 500 volts is frequently used for such work, and it is usually considered that such a pressure, although sufficient to give a disagreeable shock, is not dangerous to life. That this feeling of security is not well founded is unfortunately proved by recent fatal accidents. For power transmission in mines an ideally safe system is furnished by concentric cables with earthed sheathing, and switches, fuses, and other appliances enclosed in cast-iron cases, also earthed, and, if need be, enclosed-type motors with their casings earthed.

With regard to the wiring of ships, it is well known that an essential condition of durable wiring is that it shall be waterproof throughout. The British Admiralty for years tried all that the best materials of the usual double-wiring sort and most careful workmanship could do to secure the desired result. But the incessantly recurring faults and derangements drove them six years ago to abandon wood casing and the ordinary rubber-insulated conductors, and no longer to attempt the impossible. At the time indicated they discarded wood casing and adopted in lead sheathing of the conductors the most effectual means of rendering them permanently waterproof. It was not, however, till four years later that they fully faced the question of making the wiring systematically waterproof throughout. Cast-brass distributing fuse-boxes and cast-brass switch-boxes, all of waterproof patterns, were then adopted, and means taken to make water-tight joints between these boxes and the lead conductors.

The present patterns of distributing-boxes, etc., although they serve their purpose, are still capable of improvement, and their awkward styles admirably illustrate the difficulty of designing waterproof fittings for use in a double-wire system, where the two sides of the circuit must be insulated from each other, and both from metal of the containing boxes.

The Admiralty still adhere to double wiring, owing to fancied danger of compass disturbance from concentric wiring. In the early days of electric lighting some of her Majesty's ships were single wired, and had dynamos of unsuitable types injudiciously placed. The results were compass disturbance. (The risks of compass disturbance even from single wiring are as nothing when compared with those which may arise from the dynamos.) The navigating officers naturally became alarmed, and the alarm has not yet subsided. That well-arranged concentric wiring has no effect whatever upon the compasses of a ship has been proved by the most careful tests. The waterproof qualities of concentric wiring and the safety from fire which it ensures peculiarly adapt it for use on board ship.

The history of the development of electric light wiring in our navy is highly interesting and instructive. The conditions to be endured by wiring on board ship are admittedly severe, but it is under these circumstances that the inherent defects in a system will be most rapidly disclosed. We may profit by the experience of the Admiralty, and accept their progress as an index to the direction in which wiring practice on shore should be improved. The same defects which led to the abandonment of double wiring in wood casing in the navy exist in this system when applied to land work. The conditions on shore are less trying, and severe treatment less frequent, but the same inherent defects are there, and only await opportunity to develop.

And now with regard to possible electrolysis due to difference of potential along the outer conductor. In isolated installations where the distances are short the question of electrolysis may be dismissed as having no bearing. In cases where the distances are considerable the risk of electrolysis may be entirely avoided by adopting very simple precautions. The first of these—suggested to the writer by Mr. T. B. Murray—is to so proportion the conductivities of the inner and outer conductors that the fall in volts shall be nearly all in the inner conductor; the copper saved from the inner conductor being added to the outer in order to reduce to a minimum the difference of potential between its ends. Another method adopted by the writer is to provide between the outer conductor and its lead sheathing a very light insulation, and to earth the outer conductor only at the distant end. The layer of braiding laid for manufacturing reasons over the strands of the outer conductor before it is passed through the lead-press is sufficient for the purpose, as the maximum difference of potential between the outer conductor and the lead is only a few volts.

The risk of electrolysis is greatly over-estimated. The prejudice against earthing the return conductor is largely due to the results of the early American practice of using an earth return for street railway circuits, instead of providing an adequate return conductor. The consequence of this habit was serious damage by electrolysis to gas and water mains. But what were the conditions? In many cases the current was put to earth at the distant points at 50 volts to 100 volts above the E.M.F. of the dynamo negative, and the large currents, amounting sometimes to thousands of amperes, which had to find their way to the earth-plates at the power-house carried destruction in their path. But disappearance of these troubles has followed efficient bonding of the rails and the provision of complete metallic circuits of suitable conductivity—in other words, the substitution of a metallic earthed return for an earth return.

In dealing with distribution for electric lighting purposes we do not have to contend with such large differences of potential at different points of the system, and the difficulties are not at all comparable with those encountered in street-car work. A three wire system, with the middle earthed, and concentric wiring on each side, with the sheathings connected to the middle wire, is an ideally safe and reliable system of distribution. In a well-balanced three-wire system the fall of volts along the middle wire is negligible, and there is therefore no danger of electrolysis. No disturbance to telephones could take place. Stray currents passing between faults in the conductors would be impossible. The positive and negative conductors being each surrounded by an earthed sheathing, no current can escape from them. Leaks in concentric cables will not endure. The distance between the inner conductor and its sheathing being the only thickness of the insulation, a fault develops at once into a short-circuit which is internal to the sheathing of the cable, and the fuse at once comes into operation. But it must be repeated that faults are much less liable to occur in concentric cables than in double wiring. The importance

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and safety of the self-testing properties of concentric wiring must be obvious.

As distributing networks are enlarged and extended and the number of consumers increases, it becomes cumulatively more difficult to keep up the pretence of insulation. The present supposed insulation of the three wires is a sham, and the sooner we acknowledge it the better. Experience has proved that good insulation of all three conductors in an extensive network cannot be reliably maintained. Then why not face the difficulties, and end them by earthing the middle wire?

The initiation by Mr. Sidney Baynes of the use of 200-volt lamps and 400-volt distribution on the three-wire system has a significant bearing upon this question. That his policy from the supply engineer's point of view is a sound one is beyond doubt, and that it will be largely followed in the near future is certain. But what about the interior wiring? If the attempt is to be continued to maintain the insulation of all three wires, the possibility is introduced of having a difference of potential 400 volts between one of the wires and earth. The danger from leakage across damp woodwork and the like is therefore much increased, and possible danger to life introduced.

Recent developments and experience demand the reconsideration of this question of earthing in its relation to electric light conductors. The Board of Trade have issued regulations referring to the use of uninsulated conductors for tramway and railway work. The time is ripe for the framing of regulations relating to an uninsulated middle wire in the three-wire system of distribution.

EDINBURGH.

REPORT BY THE ELECTRIC LIGHTING COMMITTEE AS TO EXTENDING THE ELECTRIC LIGHTING PLANT.

At a meeting of the Electric Lighting Committee, on a motion by Councillor Mackenzie, as to what extensions should be made to the machinery and the mains of the electric light installation, there was submitted the following report by Prof. Kennedy:

The Edinburgh electric light station, as the committee will remember, was supplied with plant sufficient for the supply of electric energy to 40 000 lamps wired. This was the number given in my preliminary report as likely to be reached within two or three years, for private consumers. I also gave, in my preliminary report an estimate of works costs as 3d. per unit (including all office expenses) when the output was 300,000 units per annum, and 2·5d. per unit when the output reached 680,000 units per annum.

To a very great extent, in consequence (if I may be allowed to say so) of the energy and determination of the convener of the committee, the number of lamps wired already, after only 7½ months' working, is equivalent to 42,300 of 8 c.p., besides arc lamps equivalent to about 3,316 more, making in all the equivalent of about 45,600 lamps of 8 c.p. already connected up, as compared with my suggested number of 40,000 after four times as long a period.

I am glad to say that not only has the success of the light been almost phenomenal in the matter of the number of consumers, but under Mr. Monkhouse's management the economy of production has also been very remarkable. The total number of units actually sold up to date has been about 285,000 (in 34 weeks), and the total station expenses, including office charges, have been about £1,850, or an average of 1·56d. per unit sold, including units for public lamps, and including carbons and lamp trimming. This result for little more than a first half year's working, including all the summer months, when the demand is a minimum, and including also the actual start, when only 2,500 lamps were connected, is quite a record, so far as I know.

It is easy now to estimate the results up to the end of the year (37 weeks from the opening of the station), and they will be approximately as follows:

Units sold, including arc lamps		384,000
Total income	£7,750	or 4·85d. per unit.
Station expenses	£2 200	1·37d. ,, ,,
Management and central expenses	575	0·36d. ,, ,,
Total working costs	£2,775	1·73d. ,, ,,
Interest and sinking fund at £7,670 per annum	5,457	3·41d. ,, ,,
Total costs	£8,232	5·14d. ,, ,,

Thus it appears that in your first 37 weeks' working you will not only have paid all working expenses, but very nearly also all charges for interest and sinking fund, in spite of the fact that the period covered has been mainly summer time. In your first completed year of working—*i.e.*, by the middle of April next—you will have sold over 800,000 units, your total income will have been about £10,000, and you will have a credit balance of between £2,000 and £3,000, after paying every charge of which I have knowledge, including interest and sinking fund at the rate mentioned above. The total working costs will have fallen to about 1½d. per unit sold, averaged since the opening of the station.

The total capital expenditure so far as it concerns matters covered by my estimates has worked out at little less than the estimates. As you are aware, however, considerable additions have been made to the work, both in the station buildings and in the mains, which have caused additional expenditure. The result seems to me to have been the best possible justification of the policy adopted by the Town Council in making these extensions. The amount taken for interest and sinking fund is the amount fixed by the town clerk, and corresponds, of course, to the actual expenditure, and not to any hypothetical amounts.

I have thought it well to place these figures fully before you, because there is no doubt that the question of extensions has at once to be faced.

From Mr. Monkhouse's statements to me, and from my own observation of what has been going on in Edinburgh, I can hardly doubt that you must be prepared to supply current to an additional 40 000 or 50 000 lamps (beyond those at present connected) by next winter; this number at least, possibly more.

In my original scheme for the station, I allowed for filling up the low-tension side with units, each of 225 kilowatts, or about 400 i.h.p., similar to the two largest which are at present in place. I have gone into this whole question *de novo*, with the benefit of Mr. Monkhouse's experience in the actual running of the plant, but have come finally to the conclusion that I cannot improve on my original plan, and should recommend that it be adhered to. Under these circumstances, the smallest addition which would meet the case would be four more machines, each of 225 kilowatts. These together would provide for 26,400 lamps alight at once, or, say, 53,000 lamps wired beyond those at present on the circuit. The station could therefore safely supply current for 90,000 to 95,000 lamps wired, including the equivalent of the arc lamps. This number will no doubt be reached by the end of 1896, and I think the only question now is whether you should put down four or six new sets at once.

This plant would, of course, provide for all required extension of arc lamps so far as they lie on the route of continuous-current mains.

On the high-tension side of the station, the addition of the 13 lamps from the post office to Regent-terrace (already sanctioned) will practically fully load the present rectifiers, leaving of course one spare machine. The proposed lamps in Clerk-street and in Leith walk will be high tension lamps, and if these are sanctioned, two more rectifiers will be required, because half the lamps must be on an all-night circuit, and the remainder on a half-night circuit. These two rectifiers will be sufficient for 25 or 30 additional lamps for still further extensions.

Four rectifiers, when fully loaded, constitute very nearly full load for one of the existing alternators, and will therefore take up all the balance of power at present available for private high-tension lighting. For this purpose an additional machine will be required, and I think it ought to be of a capacity about double that of the present ones, or, say, 160 kilowatts. It would therefore be able to supply both private and public lighting during heavy load, leaving the existing machines to come on late at night, when the private load ceases. At the same time I believe it would conduce to economical working if a motor alternator were provided which could be driven by the battery in the daytime, so as to avoid the necessity of always keeping an engine, with boiler, actually at work.

As to buildings, nothing has to be done in the engine-rooms beyond finishing the concrete foundations for the new plant, as they were fully carried out in the first instance. The boiler-house is also large enough for many more boilers than those mentioned below. But the space which must be occupied by the new boilers is used at present as coal store, and I think it would be desirable, when work is going on at any rate, to erect the gantry and finish the coal-store above the boiler-house, as I originally schemed it, and as, I believe, it is shown in Mr. Cooper's drawings.

As to boilers, at present five out of the existing six boilers are used at full load, and the output at that time is more than can readily be done by four boilers, although the five boilers are by no means fully loaded. Four boilers more would therefore be sufficient to take up double the present output, but there would be a certain constructive convenience in adding five boilers rather than four, and I should advise that, if possible, this should be done.

The present boilers and mechanical stokers have proved efficient and convenient, and I cannot suggest any improvement on the existing type except in such matters of detail as can easily be included in a revised specification.

As to mains, the existing feeders—which contain, of course, the heaviest copper—have been laid large enough for about 75 per cent. beyond their present load, so far as they are laid in armoured cable. Those portions of them which consist of bare strip, can be nearly doubled in section without moving the roadway or pavement, and at a very moderate cost. This addition ought, no doubt, to be carried out during the open weather next spring. Existing distributing mains do not require any change. The extension of either feeders or distributing mains to new districts (such as Stockbridge, Lauriston, or Dalry) is a matter to be considered and settled by the committee, but does not press just now so much as the extension of plant, as, of course, no new roadwork can be entered on until the spring.

There is another matter which I have to bring before the committee, and which is of very considerable importance. It is a

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matter on which some decision should certainly be arrived at reasonably soon. I mean the question of the use of lamps of double voltage.

Two years ago, when I was asked to advise the Town Council on the matter of electric lighting, it had only just become possible to buy lamps having a voltage of as much as 115, and I advised the use of a three-wire system with this, the highest voltage then practicable. It was certain that later on lamps would be manufactured suitable for working at a much higher pressure, but how soon this would come about was only a matter of speculation. The system, however, which I recommended to you, and which you have carried out, was chosen so that full advantage could be taken of the new lamps whenever they came on the market.

They have come sooner than many of us expected, and are already to be had, of satisfactory quality, up to 200 and even 250 volts. I hope, therefore, that before long—that is, within the next two years or so—your system may be changed into a three-wire system, at just double its present voltage, a change which will quadruple the present carrying capacity of the mains, and which will involve very little change in the station plant, engines, and dynamos. (The capacity of the plant will not be increased, of course, but only that of the mains, as well as the distance to which continuous current can be supplied economically from the station by the existing mains.)

There are only two points of difficulty about the matter—viz., the Board of Trade regulations and the disposal of the existing lamps. As to the former, the matter has been referred by Sir Courtenay Boyle to a small committee (consisting of Lord Kelvin, Mr. Preece, and Major Cardew), and their decision will very shortly be made public. The question of existing lamps is a more formidable one. After much consideration I have come to the conclusion that the following plan, or something like it, should be adopted, and I hope to be able to carry it out even in Westminster, where we have about five times as many lamps to deal with as in Edinburgh. Let the undertakers give notice (*a*) that on and after a certain date (say, February 1, or perhaps May, 1896) their standard voltage will be 230 in respect to all consumers connected after that date; (*b*) that on and after another certain date (say, August 1, 1897) the new voltage will be standard over their whole system, new and old; and (*c*) that at any time between those dates the undertakers will supply any existing consumers with new lamps (for 230 volts) at the price of 6d. each, the old lamps becoming the property of the undertakers. The effect of this last clause would be that each consumer would run his existing set of lamps as long as possible, and then buy a new set very cheaply from the undertakers. The undertakers would probably lose about 8d. per lamp on the transaction. Your number of lamps, equivalent to 40,000 of 8 c.p., probably means 20,000 actual different lamps, and thus the total cost to you of an operation which quadrupled the capacity of mains which may have cost you £50,000 or £60,000 would be about £670—plus the wages of men employed in changing the lamps, etc.

There are no electrical difficulties in the way of making the change, and for your public low-tension arc lighting it would be an advantage—you would, in fact, get nine arcs worked for every eight which you now have without any additional cost. There are some difficulties in detail as to shops which at present use not more than two arcs, and as to a few motors, but these are small matters, which can easily be arranged, and it is unnecessary to encumber this report with purely technical details.

As to the cost of extensions, I stated to you in my report of April 8, 1893, that the cost of doubling the capacity of your plant and feeders would not exceed £30,000. It is quite certain now that this figure will considerably more than cover the extension named, and will leave a substantial margin for extension of mains into districts not yet provided with electrical energy.

One other matter I ought to mention—the question of the price per unit to be charged to consumers. Undoubtedly—as I have already pointed out in my early reports, and as is fully recognised by the committee—the way to make the electric light a success is to keep its price as low as possible. Although I am not to-day in a position to suggest a precise figure to you, I feel sure that you will be justified in making a substantial reduction either in the nominal price or in the scale of discounts, to take effect after the New Year. (Signed) ALEX B. W. KENNEDY.

The committee, after careful consideration of the foregoing report, beg to recommend that four engines and dynamos (low tension), one engine and dynamo (high tension), two rectifiers, five boilers, and all necessary apparatus be added to the existing plant. Should this recommendation be approved of, the committee crave a remit with powers to carry out the work.

THE RICHARDSON "I.R." ARC LAMP.

Mr. A. W. Richardson, of Patricroft, Manchester, the maker of the "I.R." arc lamp, claims to be the oldest arc lamp manufacturer in the provinces. His aim has been to design a lamp that would compete with foreign importations and at the same time attain all the necessary features essential in a first-class lamp, and with the aid of special machinery, tools, and appliances he states that he is enabled to place on the market a sound, practical small arc lamp which will enable users to obtain a good English article at a low price. Fig. 2 shows the mechanism of the lamp. The "I.R." is a differential direct-acting lamp, having a simple yet positive and sensitive feeding arrangement, which acts upon the carbon direct. This feeding arrangement is actuated by a pair of solenoids of large area, the cores of which are attached to a rocking lever which works the centre tube to which the feeding gear is fixed. This gear is fitted in a box below the lamp bottom plate, and so is protected. The whole is constructed of a metal which, it is said, will withstand the action of the atmosphere, and not corrode.

FIG. 1.

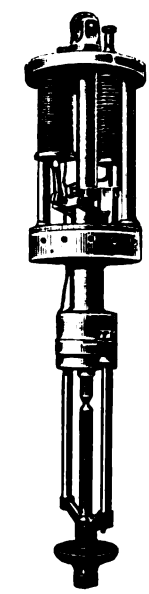

FIG. 2.

Mr. Richardson claims the following advantages for the "I.R." lamp: Cheap, sound construction, therefore durable, simple, and reliable, there being less working parts than any other; no racks, clockwork, chains, springs, pulleys, strings, make and break contacts, slide rods, flexible cords, dashpots, and no complicated delicate mechanism to get out of order; no rods to clean, as when recarboning a new carbon rod is inserted, therefore a great saving in labour. The remains of the positive carbon are used in the negative, there being, therefore, only one waste end instead of two, as in other lamps.

LEGAL INTELLIGENCE.

MITCHELL AND CO. v. MITCHELL.

The plaintiffs in this case (at the Westminster County Court on Tuesday before his Honour Judge Lumley Smith, Q.C.) are a firm of electrical engineers carrying on business in the Strand, and they sued the defendant, who resides at Grand-parade, Finchley-road, to recover a balance of account of five guineas for work done and materials supplied in connection with the installation of the electric light at the premises in question.

Mr. David Mitchell, a member of the plaintiff firm, was called, and said he had a conversation with the defendant in November last year in reference to the installation of electric light, and finally he was given an order to carry out the work. He (plaintiff) offered to give a price for the work, but the defendant said he did not want one, but wanted the work got on with at once. The order was duly carried out, and in due course an account for £15 was sent in, and various sums were subsequently paid on account, but the defendant repudiated liability for the balance, on the ground, as he contended, that there was an agreement to do the whole of the work for an inclusive price of £9. There never was any such agreement, however, either verbally or in writing, and consequently this action was brought to recover the balance.

The **Defendant** was called, and said that in consequence of a dispute which he had previously had with the plaintiffs he was particularly careful to have some distinct agreement as to the price to be paid for the work. After some conversation the plaintiff raised an objection to giving a written contract, but it was finally agreed that everything should be done for a strictly inclusive price of £9.

The jury, after a few minutes' deliberation, found a verdict for the plaintiff for the full amount claimed, and his Honour entered judgment accordingly with costs, and refused the defendant's application for time to pay.

SANDON v. THE CHELSEA ELECTRICITY SUPPLY COMPANY—FOWLER v. THE CHELSEA ELECTRICITY SUPPLY COMPANY.

These were two motions in the High Court of Justice, Chancery Division, before Mr Justice North, to restrain the defendants from carrying on their works so as to cause a nuisance to the plaintiffs. The first action was brought by the owner and some

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of the tenants of flats at 21, Cadogan-gardens, which adjoins the defendants' works. The plaintiff in the second action was the tenant of one of the flats in the same house. It will be remembered that in July last an injunction was granted in each action to restrain the defendants from continuing to carry on their works in such a manner as to cause a nuisance to the plaintiffs, but the defendants were allowed until the end of October to make such alterations in their works as would abate the nuisance. There was evidence on the part of the plaintiffs that there was still "an intolerable nuisance." On the other hand, the defendants' evidence showed that very extensive alterations had been made at their works; that the steam power used on the premises had been reduced by one-half, and that certain structural alterations had been made, and were in course of being made, to reduce the vibration.

Mr. Warmington, Q.C., and Mr. Badcock appeared for the plaintiffs in the first action; Mr. Swinfen Eady, Q.C., and Mr. Rooden for the plaintiff in the second action; Mr. Moulton, Q.C., Mr. Vernon Smith, Q.C, and Lord Robert Cecil for the defendants.

Mr. Justice North, on the evidence before him, was convinced that the nuisance had been reduced, and that the defendants had made *bonâ fide* efforts to get rid of it altogether. In the result his Lordship gave the defendants a further period of three months to complete the alterations in their works which they considered would entirely remove all causes of complaint, the operation of the injunction being suspended in the meantime. But this indulgence would only be granted on the terms of the defendants paying the plaintiffs' costs of the motions as between solicitor and client.

FORGING LAMP MARKS.

At Clerkenwell Police Court, on Wednesday, Alfred Attride, of Richmond road, Kingsland; Edward Ingold, described as an electrical engineer, of Woodlands-road, Leytonstone; and George Cosgrave, described as an electrician, of Church-street, Putney, were charged on a warrant with unlawfully applying to certain lampholders marks which resemble the trade-mark of the Edison and Swan Electric Lighting Company, Limited. Mr. Wontner prosecuted on behalf of the company, and the prisoners were separately represented.

Mr. Wontner said the defendants would be charged with conspiring to defraud the Edison and Swan Electric Lighting Company, who carried on business as electricians at Queen-street, Cheapside, and with infringing the Merchandise Marks Act. It appeared that Ingold, who was the head and front of the conspiracy, was formerly in the employment of the company as a clerk. He was discharged in 1892, and since then, it would be shown, he had been carrying on a fraudulent business, with the aid of the other defendants, by means of forging the name of the company upon lampholders resembling those manufactured by the company. Attride was accused of having had a circular stamp made at the instigation of Ingold, and Cosgrave would be shown to have used a stamp belonging to Messrs. Paterson and Cooper, electrical engineers. Cosgrave had been employed by Paterson and Cooper (who were licensed by the Edison and Swan Company to stamp lamps and sell them) and he had taken the stamp home and used it. In addition to this stamp which was used in these fraudulent transactions, there was the stamp which was made for Attride by a stampcutter at St Luke's. Ingold had a number of lamps made in Germany, and when they had been stamped they were sold at less than half the price at which they were sold by the Edison and Swan Company.

Walter Findlay, electrician, formerly in the employment of the Edison and Swan Company, said he left their service in 1892. He had since then, at Ingold's request, obtained consignments of lampholders from a maker at Cologne, and Ingold paid him for acting as agent.

The case was adjourned.

COMPANIES' MEETINGS AND REPORTS.

GUILDFORD ELECTRICITY SUPPLY COMPANY, LIMITED.

The fourth annual general meeting of this Company has been held at the County and Borough Halls, Guildford.

Mr. A. F. Asher presided, and, in presenting the annual report and balance-sheet, on behalf of the directors congratulated the Company on having been successfully floated within the past two months. It was explained, for the benefit of those shareholders who had only recently taken an interest in the Company, that the Company was formed under the name of the Holloway Electricity Supply Company, Limited, in 1892 and that under that name it first applied for a provisional order of the Board of Trade for powers to supply electricity for lighting purposes at Guildford. The name of the Company was in 1894 changed to its present form. The Chairman, in mentioning these facts, referred to the way in which the Company had in its earlier stages, been opposed by the municipal authorities of Guildford, the result of such opposition being that the Company obtained a concession for 35 years under the Electric Lighting Acts, which is probably one of the longest terms ever granted to a company of this kind, and much longer than the Company could have hoped to get if its scheme had been unopposed by the Town Council. The authorised capital of the Company is £20,000, in 3,900 ordinary shares of £5 each, and 500 founders' shares of £1 each, and the shareholders appeared pleased to find not only that sufficient capital has already been subscribed to justify the directors in going to allotment, but that a contract for the works, mains, machinery, etc., has already been signed, and an excellent site for the works obtained; also that there is every probability of the current being supplied for lighting and other purposes during the next few weeks. As was remarked, however, by Mr. Kent (one of the directors), it is hoped that further subscriptions will be received at once for ordinary shares, a considerable increase in the capital being considered necessary as soon as there is a demand for current, in order to provide, amongst other things, for the cost of connecting customers' houses and shops with the mains, and for a contemplated increase in the plant. The founders' shares, on which no dividend is payable until the ordinary shareholders have received 6 per cent. per annum, have been allotted to those gentlemen who found the money to meet the preliminary expenses of the Company.

A question having been asked as to possible opposition to this Company on the part of the Guildford Gas Company, who, in their application to Parliament for increased powers now pending, are asking for power to supply electricity, it was explained by **Mr. Kent** that this application was probably only intended to obtain for the gas company power to apply their capital to electrical purposes, in case it might be advisable for them at some future time to do so, and that if these powers were obtained it would always be necessary for the gas company to apply for a provisional order of the Board of Trade, under the Electric Lighting Acts, before any competition with this Company in electric lighting could be undertaken. The Board of Trade, Mr. Kent remarked, would not grant an order giving the gas company any electric lighting powers so long as the order obtained by this Company was in force.

Messrs Asher and Colebrook, the directors retiring by rotation, were re-elected, and the meeting terminated with a vote of thanks to the chairman.

WESTMINSTER ELECTRIC SUPPLY CORPORATION, LIMITED.

An adjourned general meeting of this Company was held on Wednesday at the Company's Offices, Eccleston-place, S.W., for the purpose of electing an auditor. Mr. James Heslop Powell presided, and it was determined that the official auditor appointed by the Board of Trade should also act as the shareholders' auditor, in order to save the trouble and expense of two yearly audits.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Brumath.—The Town Council invite tenders for lighting the town by electricity, steam power to be used. Conditions from Bürgermeister A. Bostetter, Brumath-i-Els., Germany.

Betanzos.—Tenders are invited by December 28 for the concession of the electric lighting for 25 years of the town of Betanzos, Spain. Conditions of La Direccion Gèneral de las Administraciones Locales, Madrid.

Ploesti.—The Municipality of Ploesti invites tenders by January 15 for the lighting by electricity of the 46 principal streets in the centre of the town. Conditions from La Mairie de Ploesti, Roumania.

Chelsea.—The Guardians of St. Luke, Chelsea, invite tenders for fitting up an electrical wiring installation, with fittings, in the Chelsea Infirmary extension, Cale-street, Chelsea. For particulars see advertisement columns.

Saarbruck.—The Railway Telegraphs Inspection invite tenders by December 16 for the supply of 28 standard Morse apparatus. Conditions for one mark from Die Eisenbahn-Telegrapheninspection, Saarbrücken, Germany.

Dublin.—Messrs Arnott and Co., Limited, Dublin, invite tenders from competent firms for electric light and power installation to their new premises, Henry-street and Princes-street, Dublin. For particulars see advertisement columns.

Strasburg.—The Imperial Railway Authorities in Alsace-Lorraine invite tenders by December 17 for the supply of 1,010 telegraph poles. Conditions for 70pfg. from Das Materialien-Bureau der Reichseisenbahnen in Elsass-Lothringen, Strasburg, Germany.

Cleator Moor.—Tenders are invited for an electric light installation in the central stores of the Cleator Moor Co-operative Society. For particulars apply to Mr. J. C. Teasdale, secretary, General Office, Co-operative Society, Limited, Cleator Moor, Cumberland.

Aussig.—The communal authorities propose to have built a seven-mile single-line tramway. The choice of system is left open. Contractors are invited to place themselves in communication with the Stadtrath, Aussig-a.-d.-Elbe, Prussia. Tenders are to be in by January 31.

Manchester.—The Markets Committee desire tenders for the supply and erection of accumulators, columns, lamps, and wiring for the lighting of the Foreign Animals Wharf, Mode Wheel. Copies of specification and drawings may be obtained at the city surveyor's office, Town Hall, Manchester, on deposit of £1. 1s. (which will be returned on receipt of a bona fide tender), and

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tenders are to be sent in on the forms supplied not later than 10 a.m. on December 20.

Pernambuco.—Tenders for lighting the city of Pernambuco by electricity are invited by the Government of the State of Pernambuco (Brazil). Particulars may be had on application to the Brazilian Consulate-General, Liverpool, or to the Brazilian Consulates in London, Manchester, and Glasgow.

Brussels.—The Ministère de la Guerre invites tenders by January 15 for (1) a heating installation, (2) electric lighting in the new military school to be constructed in the Avenue de la Renaissance, Brussels.—The Administration des Télégraphes require tenders by December 18 for the supply of various large lots of pine telegraph poles. Special cahier des charges No. 26 at the Brussels Bourse.

Hull.—Tenders are wanted for the supply of best South Yorkshire hard steam double-screened nuts, from January 1 to June 30, 1896, for the Electric Lighting Committee, in accordance with conditions set forth in the form of tender, which may be obtained at the electric lighting station, Dagger-lane. Tenders are to be sent to the chairman of the Electric Lighting Committee, Town Hall, by noon on 19th inst.

Mile End.—The Guardians of Mile End Old Town contemplate lighting their several establishments in Bancroft-road, Mile End-road, E., by means of the electric light, and are willing to receive from gentlemen practising as consulting electrical engineers proposals for supervising the undertaking, including preparation of all specifications and plans in connection therewith. For particulars see advertisement columns.

Transvaal.—The General Consul of the South African Republic asks tenders for the delivery of 5,000 k.g. 2 mm hard-drawn copper wire for the Government telegraphs. Tenders which are not in American Hotel, Leidsche Plein at Amsterdam, before the 20th December, 1895, will not be taken into consideration. The conditions for the delivery can be furnished on demand by Brothers Belinfante, Paveljoensgracht, The Hague, at the price of 1s.

Egremont (Cheshire).—Tenders are invited for fitting up the electric light at Seacombe, Egremont, and New Brighton Ferries, for the Wallasey Urban District Council. Specification and any further information may be obtained on application at the manager's office, Egremont Ferry, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, addressed to the chairman of the Ferry Committee, and endorsed "Tender for Electric Light," must be left at the Public Offices, Egremont, by 4 p.m. on 16th inst. The contractor will be required to enter into a bond, with approved sureties, for the performance of contract. Mr. W. Danger, clerk, Public Offices, Egremont.

Leyton.—The Leyton Urban District Council invite tenders for electric lighting works as follows: Contract No. 1, central-station buildings; (3) gas-engines, travelling cranes, piping, etc.; (4) dynamos, switchboards, etc.; (5) storage batteries; (6) five miles of mains, including laying. Specifications, general conditions, and forms of tender can be obtained on and after Monday, December 9, at the offices of Prof. Henry Robinson, C.E., 13, Victoria-street, Westminster, on payment of 5s. for each specification, etc., and tenders on printed forms, in separate envelopes, and accompanied by a £10 Bank of England note (which will be returned, unless the tender is withdrawn before the contract is signed), are to be sent to Mr. R Vincent, clerk to the Council, Town Hall, Leyton, Essex, on or before six o'clock on Tuesday, December 17.

Durban (Natal).—The Corporation desire tenders for the supply, for delivery at Durban, and fixing at Durban, of steam and electrical plant for the lighting of the borough by electricity. The work will be executed under the direction of Mr. Fletcher (borough engineer) and Mr. Hadfield (electrical engineer) at Durban. The plant required includes high-speed engines, dynamos, cables, arc and other lamps, accumulators, etc. Specifications and plans can be obtained from Mr. W. H. Radford, C.E., Angel-row, Nottingham, consulting engineer to the Corporation, on deposit of £5. 5s., which will be returned on receipt of a bona fide tender. Sealed and endorsed tenders, in duplicate, must be delivered at the offices of Messrs. Webster, Steel, and Co., agents to the Durban Corporation, 5, East India-avenue, Leadenhall-street, London, E.C., by 28th inst.

RESULTS OF TENDERS.

Bristol.—The Docks Committee have accepted the tender of Mr. Lewis for the erection of a telephone call-room at Avonmouth Dock for the National Telephone Company.

Belfast.—The Electric Committee have accepted the tenders of Messrs. J. H. Holmes and Co. and Messrs. Gill and Russell for instruments and malleable iron pipes respectively.

Ossett.—The Low Laithes Coal Company, Limited, of Gawthorpe, Ossett, R S.O., having determined to adopt electricity for their new hauling plant, the necessary order has been placed with Messrs. A. Hirst and Son, electrical engineers, of Crescent Works, Dewsbury. The plant will be capable of giving out 55 h.p.

Stafford.—The Town Council have accepted, on the recommendation of the Gas and Electricity Committee, the tender of the Stanton Ironworks Company, Limited, amounting to £65. 12s. 6d., for the steam-main to be laid from the electric station boiler-house to the gasworks boiler-house, and that of the Smethwick Boiler Covering Company, amounting to £38, for covering such steam-main with non-conducting material.

Sheffield.—The Town Council have accepted the tender of the Sheffield Electric Light and Power Company, Limited, for supplying and fixing the electric installation for the Town Hall for the sum of £720 (Sunbeam light) or £743 (Edison-Swan light), for whichever system may be recommended by the Consultation Sub-Committee; also the tender of Messrs. W. Singer and Sons, of Frome, for supplying and fixing the electroliers at the Town Hall for the sum of £1,028.

Bedford.—The Electric Light Committee of the Town Council have accepted the tender of Messrs. Robert Stevenson and Co., Limited, of Newcastle-upon-Tyne, at £467, for the supply of a centrifugal pump and engine, also surface condenser with air-pump and engine. In connection with this contract Alderman Richards said he thought it right to say, on behalf of the committee, to save any misunderstandings in the future as there were in the other contracts, that this was not the lowest tender.

BUSINESS NOTES.

Swansea.—The tenders for the Swansea electric lighting scheme have been received, and will be considered at the meeting of the Electric Lighting Committee.

Harrogate.—The town clerk has reported that an enquiry is to be held by Mr. W. J. B. Clerke, M.I.C.E., into the borrowing of £27,000 for purposes of electric lighting.

Berlin.—The construction of the projected electric circular railway between Berlin and the southern suburbs is now definitely assured, the Berlin Magistracy having granted the necessary license.

Kidderminster.—The plans of the proposed electric tramway have been deposited with the town clerk, and the borough surveyor has been instructed to examine and report upon them to the Town Council

Chelmsford.—At a meeting of the Relief Committee in connection with the fire at Messrs. Crompton and Co.'s, it was reported that nearly all the men were in employment again, only 30 remaining still out.

The Telegraph in Brazil.—On November 7 was published the decree opening a credit of 200,000dol. for an extension of the State telegraph line in Maranhao to the town of Palma, in the State of Goyaz.

Queenstown.—The Town Commissioners have passed the application to the Board of Trade for a provisional order to provide the town with electric light. The price of gas in Queenstown is at present 4s. 9d. per 1,000ft.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended December 8 amounted to £1,042, as compared with £855 in the corresponding week of last year, being an increase of £187.

Leeds.—The Tramways Committee have not yet received the report of Dr Hopkinson on the proposed experiment to be made in electrical traction in Leeds, and meanwhile do not intend to go further into the tramway haulage question.

Connobbio (Italy).—It appears probable that the electric light installation will be in operation on January 1. There are already numerous applications, and only the approval of the superior authorities is awaited in order to begin work.

Fleetwood.—The report of the Highways and Markets Committee will recommend the Town Council not to accept the proposals of Messrs. Bennett and Druce, electrical engineers, Preston, for the transfer of the Fleetwood Electric Lighting Order, 1890.

Milan.—The work of installing the electric light in the Church of St. Ambrogio is about to be begun. The church will be entirely lighted by incandescent lamps, except only the altars, where, for reasons of ritual, only wax candles or oil is allowable for lighting purposes.

Hammersmith (London).—The Vestry have decided to engage the services of an expert at a cost not exceeding 200 guineas to advise them on the question of electric light and to make a complete report on the schemes and tenders for the lighting of the compulsory area.

Bowness-on-Windermere.—A member of the District Council has asked why the electric lamps were lighted the previous Sunday evening, when it was just about full moon? As he was a pretty large ratepayer he considered it a proper question. The Surveyor said they were not lighted to his knowledge.

Bangor (N. Wales).—A sub-committee, composed of Dr. Langford Jones, Dr. Grey Edwards, Messrs. R. Davies and H. Lewis, have been appointed by the City Council to prepare evidence for submission to the inspector of the Local Government Board upon the enquiry as to the loan for electric light.

Woking Electric Supply Company, Limited.—This Company has been registered with a capital of £20,000 in £1 shares. Objects: to enter into an agreement with A. G. New and A. J. Mayne, and to carry on the business of an electric lighting company in the parish of Woking and neighbourhood.

City and South London Railway.—The returns for the week ended December 8 were £977, compared with £941 for the corresponding period of 1894, being an increase of £36. The total receipts for the half-year 1895 were £20,527, compared with £20,518 for the corresponding period of 1894, being an increase of £9.

Dudley.—The Streets and Gas Committee of the Town Council have reported that the deputation appointed by the committee had waited upon the Dudley Gaslight Company, and that the directors stated that they could not under present circumstances reduce the price of gas. A member said that it was admitted that the Dudley gas was poor.

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Newport (Staffs.).—The Urban District Council have received a letter from Mr. Heane, secretary to the Newport Gaslight and Coke Company, offering the concern of the company to the Council for £10,000, but the Council declined the offer. Councillor Smith said if the electric light paid in a town with gas at 2s. 3d. per thousand, it must pay in Newport with gas at 4s. 6d.

Windsor Electrical Installation Company, Limited.—This Company has been registered with a capital of £10,000 in £1 shares. Object: to acquire the undertaking of the Windsor Electrical Installation Company, and to carry on the businesses of electrical engineers, electricians, etc., in all their respective branches. Registered office: Albany House, Frances-road, Windsor.

Ipswich.—Messrs. Fraser, who supply two arc lamps to the Corporation for street-lighting from their private installation, have asked to be relieved from their contract so far as business hours are concerned, and the Corporation have agreed to this subject to Messrs. Fraser paying for additional gas lamps required to take the place of the arc lamps. The latter will still be run after the shop closes.

Electric and General Investment Company, Limited.—The directors have declared an interim dividend on the capital paid up on the ordinary shares of the Company at the rate of 10 per cent. per annum for the six months ended November 30 last, the dividend to be payable on and after the 23rd inst. The transfer-books and register of members will be closed from Monday to December 23 inclusive.

Belfast.—At the meeting of the Electric Committee considerable discussion took place about the gas-engines not giving entire satisfaction, but no report was submitted. Mr. M'Cowen, the engineer, stated that orders for illuminating shops and business establishments had come in almost up to the full extent of their lighting power, and a short extension of main to Messrs. Kirker, Sons, and Co.'s premises was ordered.

Copper.—A Michigan newspaper is responsible for the assurance that the Calumet and Hecla Copper Mine, which recently increased its output to a large extent, will revert to the old rate of production at the beginning of the year. The company is represented as having "no desire to flood the market with copper, or to increase the production to an extent that would threaten the maintenance of a price not below 11 cents per pound."

Huddersfield.—The Town Council have passed the formal resolution for an application for a provisional order to supply electric energy to the Longwood district, but the decision as to the "omnibus" Bill, which, among other matters, covers the tramway question, was postponed. At the town's meeting held to consider this Bill there was great opposition to some of the provisions, and a poll of the town has been asked for.

Electric Tramways in Scandinavia.—A company has been formed in Bergen, Norway, for the purpose of building an electric tramline, the capital of some £50,000 being to a great extent German, and, naturally, a German firm will be entrusted with the contract. In Gothenburg, Sweden, an electric tramway is under contemplation, proceeding from the station of the Bergslagernes Railway through the most populous parts of the town.

Aberystwyth.—Councillor Harries, at the last meeting of the Town Council, had on the agenda the following motion: "That the Public Lights Committee be required to consider and report on the desirability and probable cost of lighting the Meat and General Market, the town clock, and the Old Assembly Rooms by means of the electric light, and that an arc lamp be placed at a point to be selected at or near the Angel Inn." The motion was carried.

Clerkenwell (London).—The County of London and Brush Electric Lighting Company have given notice to the Vestry that on the following week they would be prepared to switch in several of the leading thoroughfares of the parish. Mr. Putterill asked if all the transformer-chambers were properly drained? Mr. Walton thought not. He knew of one case where there was no connection between the transformer-chamber and the gully. The surveyor was requested to see to this.

Yeadon (Yorks.).—The Urban District Council have decided to appoint Mr. Page, assistant to Mr. Medhurst, electrical engineer, in conjunction with Mr. Wilson, the Council's collector, to make a canvass of the township and ascertain the number of electric lights which would be taken up by the inhabitants. The information is needed for an adjourned ratepayers' meeting, to be heid on the 23rd inst., for the purpose of determining whether or no the electric lighting scheme shall be proceeded with.

Aylesbury.—A special meeting of the Urban District Council has been held for the purpose of considering the desirability of applying to the Board of Trade for a license as defined by the Electric Lighting Act, 1882, to supply electricity under the said Act for public and private purposes within the area of the urban sanitary district of Aylesbury, and to decide if such application should be made. After some little discussion it was unanimously resolved that nothing should be done in the matter.

Appointment Vacant.—There is required, for the Devon County Asylum, Exminster, a competent fitter to take charge of the machinery, including pumping, heating, and electric lighting. Applicants must be capable of executing all ordinary repairs. Wages, £2. 2s. a week and cottage. Applications, in writing, stating past experience, and accompanied by not more than three testimonials, to be sent to Mr. Arthur E Ward, 9, Bedford-circus, Exeter, clerk to the Visiting Committee, by 16th inst.

Colwyn Bay (N. Wales).—On the proposal that the District Council should oppose in the next Parliament the Colwyn Bay and District Dissolution and Reincorporation of Colwyn Bay and District Gas and Lighting Company Bill, as it was in contravention of the Council's Electric Light Company, etc., Bill, and against the interest of the ratepayers of the district, which had been adjourned from last meeting, coming up for discussion, a heated debate took place, and ultimately the resolution was lost.

Bath.—A recommendation from the Technical Education Committee of the Town Council, and confirmed by the Municipal Buildings Committee, that gas be laid on to the new schools, was questioned by Mr. Hallett, who alluded to the sanitary advantages of electric light, and pointed out that it had been placed in the Municipal Buildings, where it was not so necessary. Alderman Sturges took a similar view. Alderman Bright said they had the question of lighting under consideration. The report was then adopted.

Eastern Extension Telegraph Company, Limited.—An interim dividend has been declared for the quarter ended September 30 last of 2s. 6d. per share, free of income-tax, payable on the 15th prox. The share register will be closed from the 7th to the 14th prox., both days inclusive. The coupons of the Company's 5 per cent. Australian Government subsidy debentures due January 1 next will be paid on and after that date, at Messrs. Barclay, Bevan, and Co.'s bank, 54, Lombard-street, E.C. Coupons must be left three clear days for examination.

The Tariff for International Telegrams.—Signor Ferraris, the Italian Minister of Posts and Telegraphs, with a view to reducing the tariff for international telegrams, has, says *Elettricità* of December 8, proposed to the States constituting the Postal Union that an international tariff should be adopted equal to the sum of the inland charges of the States through which the telegram has to pass. Thus a telegram dispatched from Rome to London would pay a rate obtained by adding together the charges for an inland telegram in Italy, France, and England.

Ayr.—The Town Council have remitted to the Electric Lighting Sub-Committee a motion, "That a committee be appointed to consider the advisability of adopting tramways between Ayr and outlying districts, to be driven by oil, electric, or steam motive power, or cable or horses, and with power to enquire as to same and report." It was agreed to get a telephone connection to the electric light works. The clerk was instructed, on the suggestion of Mr. Hammond, to write to Messrs. Siemens and Messrs. Fowler urging them to push on with their contracts.

North Shields.—Mr. A. A. C. Swinton has at present in hand an electric power-transmission plant of considerable size for Smith's Dock Company, North Shields. The plant will be used for pumping out the water on a large new pontoon dock, and will consist of two sets of Belliss engines and Crompton dynamos, giving together 570 e.h.p., supplying eight 60-h.p. electromotors of Messrs. Scott and Mountain's manufacture, each coupled direct to an 18in. Gwynne centrifugal pump. This is probably the first instance in which electricity has been applied to the raising of a floating dock.

Brandon and Byshottles (Durham).—The Urban District Council have received a letter from the Local Government Board referring to the proposal to light Brandon and Byshottles by electricity, and pointing out that they would not before entertaining an application for sanction to a loan require the Urban District Council to obtain a provisional order, but that if a license were obtained the Board would limit the period for the repayment of any loan which they might sanction to the period for which the license was granted. Such period could not exceed seven years.

Sheffield.—On the formal resolution for the Corporation Tramways Bill, giving power to take over and work the existing tramways of the city, coming before the Council, opposition was raised by Alderman Carter and others, but eventually, when a division was taken, it was found that there were 48 votes for going forward with the Corporation Bill, four against, and five neuter. Afterwards formal resolutions were carried to oppose the Bills of the Sheffield Tramways Company, the Sheffield District and Rotherham Tramways, and the Sheffield District Railway; and a retainer was given the town clerk to conduct the Bill of the Corporation and the opposition to the outside Bills.

Wells (Somerset).—The report presented by the Electric Lighting Committee to the Town Council recommended that the preparations for the installation of the electric light be proceeded with, and asked that the committee might be empowered to select a site for the electric light works. The report was adopted by the Council. Subsequently, however, Mr. G. W. Wheeler moved that the whole question of electric lighting be left in abeyance for one week, and that the town clerk be instructed to offer the sum of £14,000 for the gas company's works. This was seconded, and, after much discussion, carried by the casting vote of the Mayor. The gas company ask £19,680.

South Staffordshire Tramways.—The town clerk of Walsall has received a letter from the secretary to the Electric Construction Company, Limited, stating that they had given notice to the South Staffordshire Tramway Company that they could not continue to run the electric portion of the latter company's lines on the present terms beyond the end of the month, when the existing arrangement would terminate. The reason given for this notice was that the road bed of the line was in a bad condition. The Town Clerk said the letter was of such importance to the town that it had been brought before the Council at the earliest possible moment, and on the suggestion of the Mayor the matter was referred to the Streets Committee.

The Rumoured Resignation of Sir William van Horne, which is announced from Montreal, would a year or two ago, the London *Chronicle* says, have been an even more momentous Canadian public event than the retirement of the Premier of the Dominion.

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Those were the days when, as the saying went, the Canadian Pacific Railway Company ruled Canada and Van Horne ruled the Canadian Pacific. Sir William van Horne started life as a 13-year-old telegraph operator on the Illinois Central Railway, and mounted by stages till he became general manager and vice president of the Chicago, Milwaukee, and St. Paul Railway. That was in 1880, in which year Canada began in earnest her stupendous task of carrying an inter-provincial railway from Atlantic to Pacific.

Bury St. Edmunds.—The Mayor (Mr. Oliver), the borough surveyor, and two members of the Electric Lighting Committee having visited the Bedford electric lighting works and made enquiries, have reported that they were informed that although when the works were started it was not absolutely certain there would be a customer, the works were now being carried on at a profit. As was stated in our last issue, Mr. Medhurst, electrical engineer, has been instructed to prepare a scheme for lighting the borough by electricity, but it was understood the committee did not bind themselves to any particular scheme, or even to carry out any scheme of electric lighting at all There are private installations in the town for shop-lighting, and these are reported to be giving great satisfaction.

Aberdeen.—The electric light has just been introduced into the handsome offices of the Northern Assurance Company, 1, Union-terrace. There are about 100 lamps distributed throughout the building. In the counting house are three elegant electroliers, the lamps being covered with artistic vine-shaped shades. There are five lamps in the manager's room, five in the board-room, three in the secretary's office, three in the telephone-room; and the safes and strong-rooms, situated on the basement flat, are all efficiently lighted. The offices of Messrs. Adam, Thomson, and Ross, and Messrs. Wilsone and Duffus, advocates, who are tenants in the building, are also lighted by electricity. The lamps used are of 16 c p. and 32 c p. The installation was fitted up by Messrs. Shirras, Laing, and Co., of Aberdeen.

The "Radiant" Incandescent Lamp.—This improved incandescent electric lamp is made by Messrs. Rose and Bird, Limited, of 120 and 121, Newgate-street London, E C., at their works in Westminster, under the personal supervision of the director of the works. The filament, manufactured by a new process, is said to be of remarkable hardness, strength and uniformity, rendering the life of the lamp very much longer for the same initial efficiency, and the candle-power is claimed to be maintained to a much greater degree than in any other lamp on the market, and the amount of current consumed much smaller—most important considerations to users of electric light. The company undertake the manufacture of any special lamp required, and careful attention is given to all requirements as to voltage, candle-power, and efficiency.

Halstead (Essex).—The clerk to the District Council has been directed to reply to the gas company's letter as to the price of gas that the Council were not satisfied with the company's terms, which they regarded as simply giving a discount for cash. The Council would not be satisfied if they did not have a reduction of 5d. per 1,000ft. Mr. Adams asked if the Council adopted electric lighting in place of gas whether private customers would be supplied? Several Councillors: Yes. Mr. Adams: Well, then, I should think we can get our light at a much cheaper rate. I'll move that the electric light question be seriously considered by the committee with a view to substituting electric light for gas. The Chairman: I think the committee are considering it. Mr. Carter: Yes, sir; but they would be strengthened by such a resolution. Mr. Clark seconded the resolution, which was agreed to.

Ripon.—The Mayor has moved the adoption of the minutes of the Gasworks Committee, of which he is chairman. These included an application by Messrs. G. Harrison and Co., electricians, of Ure Bank Engine Works, for permission to cross Minster-road with overhead wires for the purpose of lighting the cathedral by electricity. The town clerk laid before the gas company the position of the Council as the lighting authority of the city, and the committee resolved to recommend the Dean and Chapter to allow Messrs. Harrison and Co. to place the generating works on the south side of the cathedral, so that the experiment of lighting the cathedral might be carried out entirely within the premises of the Dean and Chapter, and avoid crossing the street. The town clerk was also instructed to obtain information as to the cost of a license from the Board of Trade to sanction the Corporation supplying electricity within the city

Blackpool—The minutes of the Electric Lighting and Tramways Committee, as submitted to the last meeting of the Town Council, contained the following: "Alderman Bickerstaffe was appointed chairman. The borough electrical engineer is to submit a scheme for any necessary extension of the electric lighting plant. The letter from the Blackpool Tradesmen's Association as to additional light in business streets was referred to the Street Lighting Committee. The letter from Messrs. Finch and Johnson, as to alleged nuisance from the electricity works, was referred to the town clerk and borough electrical engineer. Two new tramway cars to be purchased after first submitting tenders. The letter from Mr B Sykes, as to the proposed tramway from Blackpool to Fleetwood, was referred to the Parliamentary Sub Committee. The tramway traffic manager is to submit a scheme for contract passes." After discussion, the minutes were passed.

Derby.—In the Town Council Mr. Hart rose to make a personal explanation. He said that he had been criticised for stating to his constituents that a great amount of unnecessary money had been spent on the electric light station, and that the ratepayers had not had full value for their money. He went through a large number of figures in support of that statement, and called the attention of the Council to cases where sums of money had been paid for extras not included in the contracts, and, in conclusion, said that he was stronger than ever of the opinion that a large amount had been spent needlessly, and that results equally as good might have been obtained by far less expenditure. Alderman Leech said that he was quite prepared to show Mr. Hart that in regard to the figures he had quoted he was under a misapprehension, and that all his arguments could be answered to the satisfaction of the Corporation. The Mayor hoped Mr. Leech would defer his reply to a future meeting of the Council, and the matter then dropped.

Pitlochry (N.B.).—About four years ago Prof Forbes, son of the late Principal Forbes, of St. Andrew's, whose family has had a connection with Pitlochry for the last 40 years, devised a scheme for lighting Pitlochry by electricity, the motive power to be derived from the Falls of Tummel. At that time no further steps could be taken, as the proprietor of Faskally, being under age, could give no title to the water. Mr. A E. Butter, of Faskally, has, however, now agreed to have details of the proposal worked out, with the view of ascertaining whether the electric light could be supplied at a reasonable cost. Prof. Forbes (of Niagara fame) has, it is stated, been communicated with, and it is expected that a definite scheme will shortly be arranged The gas supply has at times lately proved inadequate, and the company were meditating an extension of their works, but should electricity be introduced this will be unnecessary. It is thought that the gas company might take up both systems, thus preventing rivalry, and securing economy in the management.

Stapleton (Glos.).—The committee appointed by the Urban District Council to enquire into the possibility of the Council adopting electricity as the public illuminant for the district, have presented a preliminary report. They were not yet prepared with a report on the financial aspect of the question, but were of opinion that the cost of providing the power for lighting such a large district would be prohibitive, especially from one station, and that unless some natural available power could be secured, as an auxiliary to steam power, it would be necessary to erect extra stations to light separately such detached districts as Eastville, Stapleton, Ashley-down, and Fishponds. The committee further reported that they understood that the Great Western Light and Power Company were making an application to the Board of Trade for a provisional order empowering them to supply electric light and power in the district, and that it should be opposed. The Chairman then proposed that the Council oppose the application. This was carried unanimously.

Glasgow.—The Corporation tramway sub-committee on mechanical motors have reported that after consideration of the question they were of opinion that some form of mechanical motor should be tried on one of the tramway routes, provided the committee, on enquiry, were satisfied that such motor would be more efficient and economical than the present mode of haulage. With that object they recommended that an exhaustive enquiry should be made as to the various motors in actual work under conditions similar to those of the route proposed to be experimented on, and that the remit to them should be extended accordingly, with power to call in such technical assistance as they might consider necessary. Mr. Walter Paton moved the approval of the minute. Bailie M'Cutcheon seconded. Treasurer Gray took exception to the proposal. They had only just begun to run the tramways at a cost of £400,000 by means of horse haulage. They should pay off some of the debt before they commenced this exhaustive enquiry. But the minute was ultimately approved.

Brighton.—The *Sussex Daily News* says: "While the extension of electric lighting in the main inland thoroughfares in Brighton is warmly welcomed, there is one matter in connection therewith which is not received with unanimous approval—the erection of the lamp standards in the centre of such busy traffic centres as the bottom of West-street and the New-road entrance to North street. The objection comes from drivers of vehicles. One gentleman, whose patronage is extended to the town throughout the whole of the winter season, condemns the standard as unnecessary and dangerous. There is certainly a good deal to be said for the contention that the spots mentioned could be just as well illuminated if the pavements were made the site of the erections." At a complimentary dinner to Councillor T. H. Richards, Councillor Stafford, referring to what had been said as to the lighting of certain squares in that district, mentioned that a scheme was on foot for the better lighting of side streets by incandescent electricity, and by utilising the existing gas standards. The electricity undertaking generally had, he said, been a source of great profit to the ratepayers, and had helped to bring about a reduction in the rates.

Worcester.—Alderman Airey called attention at the last City Council meeting to the accounts for coal for the work of the Electricity Committee, amounting to £461, and said the whole accounts submitted by that committee amounted to £952. 5s. 3d. He understood that when the electricity works were placed at Powick the object was to dispense with steam power, and that they would have water power sufficient for all requirements. Alderman Williamson (chairman of the Electricity Committee) remarked that the Council could not have been under the impression indicated by Alderman Airey, or they would not have laid down steam plant at a cost of £7,000 or £8,000. As to the amount of coal consumed, the season had been abnormally dry, it having been one of the driest they had had for 20 years, and they had suffered very much from that. But even if they had had an average flow of water, they would have had to use a considerable quantity of coal. The amount of coal used was, he thought, exaggerated by some members, for the total cost of the coal used at the works to the end of September was £638. 4s. 8d., including

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haulage, and this he did not think was at all a large amount, considering the work done and the dryness of the season.

Hampton Wick (Middlesex).—The Lighting Committee of the District Council have reported as follows: "The Lighting Committee, aided by the surveyor, have consulted the authorities of Kingston on the question of electric lighting for Hampton Wick. They found that the Corporation are unable to quote a price for public lamps, as the cost would greatly depend on the number of houses which would take a supply of electricity. To ascertain this, the Corporation ask to be allowed to send a circular to the inhabitants of this district. The committee recommend that this be agreed to. The gas company undertake to substitute incandescent gas lights for the present lamps at a capital charge of 10s. 9d. per lamp, without increased yearly charge, where the present lanterns are not too worn out for the change In any case, electric lighting could not be had under two years. Its cost would considerably exceed that of the incandescent lights, and the parish would be committed to it for at least 25 years. Under the circumstances your committee recommend that the village, from the bottom of Church-grove to the railway station, be lit with the incandescent light," etc. Ultimately the matter was postponed.

Bucklow (Cheshire).—Mr. Fawcus and Mr. Fairlie have appeared before the Rural District Council on behalf of the Altrincham Electric Supply, Limited, in connection with their request for the consent of the Council to the application of the Board of Trade for a provisional order to extend the area of supply within the Council's district. A difficulty has arisen from time to time owing to complaints that the company had not left the footpaths in a satisfactory condition. This being the case, the Council desired some assurance from Mr. Fawcus as to the future. Mr. Fawcus agreed to repay to the Council the expense they had incurred in placing the footpaths in proper condition, and to pay any further charges they might be put to in making the footpaths in a satisfactory condition. Also for the future, not only as regarded the new, but the old area, on behalf of his company, he agreed to a scale of charges for the maintenance of roads and pavements broken up by the company, after they had been filled up. He further consented, on behalf of the company, to an agreement being entered into similar to the last one, as to the purchase by the Bucklow and other authorities. After fully discussing the matter, the Council gave their consent to the application to the Board of Trade.

Weybridge.—Mr Bilney has submitted to the Urban Council a report of the committee appointed to confer with the chairman and another representative of the Weybridge Electric Supply Company. He also said he had received a letter to the effect that the company was prepared to transfer the provisional order to the Council on payment of the nominal sum of £100 before December 15. He thought, however, the Council ought to get an assurance from the Board of Trade—in the event of their purchasing the order—that the order would be vested in them to the exclusion of any contractors who wished to light the place The Chairman remarked that the order would probably be revoked soon, and he suggested that the Council might be able to get the order without the payment of the £100 Mr. Bilney said the committee had put that matter before the representatives of the company, but they refuse to entertain it; in fact, he was rather surprised to have seen the concessions contained in the letter to him Dr. Powell said that as the present committee had done their work so well, he proposed they should continue the negotiations with the company. Messrs. Bilney, Chambers, and Dix were then reappointed to again confer with the representatives of the company on the subject.

Electric Traction in India.—The last number of the *Indian Engineer* reports that trial trips were being made by Mr. Gadsby, the electrical engineer of the Madras Tramway Company, on portions of the new sections of the line to be worked by the overhead system. The wire which is to supply the current for these sections has been taken underground from the power station along Whannels-road over St. Andrew's Bridge along the Coum and across to Swami Naick's-street, Chintadripet, where it joins the line and is then carried overhead on posts. The cars to be run on this line are similar to those now running, except that they will be lighted by electricity from the overhead wire. Portions of the line were fit for working at once, but it was considered unsafe to work without lightning arresters, which were shortly expected. The same journal discusses the question of tramway traction for Calcutta. It says: "The solution of the problem of a suitable mode of traction for tramways in Calcutta hinges itself on the accommodation which its streets will provide. Electricity has been tried in Madras, and after the conduit system had been abandoned for the overhead or trolley system the latter, having proved fairly successful, finds many advocates. But we are decidedly of opinion that electrical traction, as now understood, is wholly unsuited to Calcutta."

Burslem.—The committee of the Town Council have reported that they had considered the proposed agreement with the North Staffordshire Tramways Company, at a meeting at which Mr. Sellon, electrical engineer, and Mr. Garcke attended, as a deputation on behalf of the company, and explained their views with respect to the clauses relating to the power of the Corporation to purchase the undertaking within the borough at the end of 22 years, on paying to the company a sum equal to the cost of the structural equipment less a deduction of 5 per cent. for depreciation, in addition to the value of the permanent way and rails. They also gave a positive assurance that the tramway extensions to Goldenhill, Smallthorne, and Longport would be carried out by the company within two years. The committee recommended that the agreement be approved of, subject to clauses being inserted binding the tramway company to make and work these extensions, and they further recommended that a clause be added to the agreement that the company should also make and work an extension to Wolstanton. After some discussion it was resolved to refer the purchase clause back to the General Purposes Committee for further consideration, after another interview with Mr. Sellon, with power to close the matter, and with this exception the report was adopted.

Barnet (Herts.).—The report of the Electric Lighting Committee has been considered by the Urban District Council. Nine meetings had, the report stated, been held since May last, with the view of gaining information as to the annual cost of public lighting by electricity as compared with the existing method of lighting; the systems to be adopted for public and private lighting respectively; the efficiency of the light after installation; and the best available method of introducing the light, having regard to initial outlay. As a result of interviews with representatives from the firm of Messrs. Vaughan and Brown, electrical engineers, of Kirby-street, Farringdon-road, and correspondence with the same firm, the committee found that a satisfactory installation would involve an initial outlay of about £8,000. Owing to its compactness Barnet was eminently suitable for the electric light, but the ultimate financial success of the undertaking would depend upon the number of private consumers. Messrs. Vaughan and Brown had been asked to provide the capital upon the provisional order being assigned to them, but they were not willing to take that responsibility. The committee, in view of other approaching liabilities connected with the extension of the district, felt that it could not advise the Council to at present undertake a scheme of electric lighting. Moreover, the committee felt that it would be inadvisable for the Council to lose the provisional order. The report was adopted.

Neston and Parkgate (Cheshire).—Mr. F. Pocklington, of the firm of Messrs. Callender, who have done electric lighting in Liverpool, and are engaged in it in Birkenhead, attended the last meeting of the Urban District Council. Mr. Grenfell said Mr. Haigh had introduced Mr Pocklington to him, and the latter had voluntarily offered to answer any questions in reference to electric lighting. Mr. Pocklington was closely questioned by Mr. Pemberton as to the numerous points included in Mr. Marsh's scheme and as to the general details in connection with electric lighting. Other members also questioned Mr. Pocklington, and the latter, having been thanked by the Council, afterwards withdrew. Mr. Pemberton said he was sceptical as to whether the scheme proposed could be carried out for the figures named, but he was open to conviction. Several of the most influential ratepayers in the district had spoken to him on the matter, and had pointed out that the Council were placing the sub-committee in an undignified position by causing them to ask for private subscriptions to prosecute their enquiries. A motion in favour of enquiring further into the practicability of lighting the district at a reasonable cost had been passed by a large majority at a public meeting and it was only fair that the public should pay for the enquiry they had asked for. He therefore moved that the sub-committee be empowered to spend the sum of 20 guineas in obtaining the necessary reports. This was carried unanimously.

Cardiff.—The *Western Mail* says: "A small but influential syndicate has been formed at Cardiff for the purpose of working two patents, one of which is for making metallic insulators, and the other for an improved method of making an insulated tubing for electric wiring purposes. The patentees (Messrs. Alfred J. P. Whitaker and F G. Treharne) have secured very suitable premises on the East Moors, Cardiff, adjoining the works of the Cardiff Tin-stamping and Enamel Company, Limited, and they are now being fitted up with the necessary plant, so that work can be commenced not later than January 1 next. The subscribers to the syndicate are: Her Grace the Duchess of Marlborough, Lord William Beresford, V.C., Sir William Thomas Lewis, Mr. Edward Davies, J.P. Alderman Mathias, J.P. (Porth), Mr. J. W. Palmer, Mr. Alfred J P. Whitaker, Mr. F. Gwilym Treharne (analytical chemist), Mr. G. C Downing, Mr. E J. Hancock, Mr. J. E. Gunn, and Dr. M. H Greener. The first directors of the syndicate will be Lord William Beresford, V.C. (chairman), Mr. Edward Davies, J P, Alderman W. H. Mathias, J.P., Mr. Alfred J. P. Whitaker, and Mr F. G Treharne. The solicitors are Messrs. Downing and Handcock, London and Cardiff Very few enterprises in Cardiff have been started under more favourable auspices. One of our representatives on Wednesday visited the site of the new industry, and found the machinery and preparations generally so well advanced that there is every reason to hope everything will be in readiness to start on January 1 next. The most searching tests have been successfully applied, and the patents, it is believed, will effect a revolution in the process of insulation."

Edinburgh.—The Lighting Committee of the Edinburgh Town Council have remitted to a sub committee proposals for the lighting by electricity of the following thoroughfares: from Leith to Pilrig, southward to Salisbury-place, Fountainbridge, from Regent-terrace to Abbeyhill, along Lauriston to Tolcross, and Dalry-road. Lord Kingsburgh has read a communication at a meeting of the Royal Scottish Society of Arts, in the course of which he remarked that as regarded the use of electricity they could have no more striking example of the development that had taken place than their own city of Edinburgh at the present moment. It was an interesting fact that in Edinburgh Prof Kennedy, the skilled adviser of the Corporation, had laid his plans upon the footing that provision for 40,000 lamps would be amply sufficient for the next three years, and still at the end of 15 months—and when

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they had only had an actual supply of light for six or seven months—the whole number of lamps was already taken up, and the Corporation were engaged in a frantic effort to make the plant sufficient for all demands that might be made upon it. Several gentlemen offered observations on the communication. One of them was Councillor Mackenzie, who, as convener of the Electric Lighting Committee of the Corporation, said that they hoped to present a report to the Town Council promising to reduce the price of the light to consumers from 6d. to 5d. a unit, to abolish meter rents, and further to reduce the price charged to the city for street lighting. Even then the committee trusted to have a handsome balance. The only danger they anticipated at present was that people would use the light in an extravagant and careless manner. Taking everything into account, he contended that the electric light, even at 6d. a unit, was cheaper than gas.

Llanelly.—The Property and Estate Committee of the Borough Council recommended the Council to agree to transfer their electric lighting order to Messrs. Howell upon the following terms: "Mr. Howell to pay £200 for the order. All costs of transfer to be paid by the purchaser. Option of purchase by Council at the end of five years, and subsequent periods of seven years, upon the following terms: goodwill for the first five years £1,500, afterwards three years' previous profits; going plant to be taken at a valuation, such going plant to include land, mains, and cost of laying down same, buildings and machinery, public lamps (if any erected) at cost of company. If the Council purchase within the first five years, they have to repay Messrs. J. C. Howell £150 in respect of the order. After that period the said £150 to be subject to proportionable yearly reductions, Council not to pay anything in respect of promotion of expenses upon the retransfer to them. Council not to give their consent to any other company during the agreement with Messrs. J. C. Howell." Mr. John Griffiths thought that the Board ought not to part with the order for less than what it cost them to obtain—£280 Mr. Guest said that one of the conditions ought to be that the Council would not give consent to any other company coming into the town, unless Messrs. Howell refused to do any work which the Council thought was required. Suppose for instance, the New Dock district required to be lighted with electricity in 10 years' time, and Messrs. Howell were not prepared to do it. Then the Council should have the power to call in another company to carry out the work. He believed that that was intended as one of the conditions by the committee Mr. Brodie thought that a proviso should be added to the conditions with regard to the buildings, etc., that they should be such as to be properly available for the purpose After some further discussion, the additions suggested were incorporated in the minutes, and in that form were unanimously approved.

Tunbridge Wells.—The Lighting Committee of the Town Council have decided that Mr. H Preece should superintend the carrying out of the extension of the central station at a remuneration of 2½ per cent on the additional £12 000 The contractors for the dynamos agreed to at once place in hand a new machine to replace one of the present ones, and would then modify the other till the efficiency was raised, and they trusted the third machine would be used for the extensions This was agreed to, on the understanding that the committee were under no responsibility to purchase the third machine, and that they held the contractors liable for any loss by the machinery not being up to the specified efficiency. The telephone company wrote calling attention to the disturbance of their system at Tunbridge Wells, and suggested that the engineers of the Corporation and the company should confer with a view to ascertaining whether the cause of the disturbance could be easily and speedily removed. The matter was referred to Mr. Preece, who had an interview subsequently, and wrote that he hoped to be able to report at the next meeting. An order for 100 meters was given. The resident engineer reported that Sir David Salomons had agreed to pay all the expenses of the opening of the electric light station, and the thanks of the committee were voted Sir David for his generous offer. A balance-sheet of the recent electrical exhibition was produced showing a net profit of £108. The gas company were requested to comply with the statute, and give notice before breaking up the streets in future in order that precautions may be taken to prevent damage to the electric light mains. The question of additional lighting in the side streets was referred to a sub-committee. The Local Government Board wrote sanctioning the loan of £12,000 to be repaid in 25 years. The borough surveyor was instructed to prepare plans for extending the central station, and the consulting engineer to obtain tenders for the new machinery required. It was decided not to employ a clerk of the works, but to place the matter in the hands of the resident engineer. Mrs Pierson wrote that her well in Cumberland-walk had dried up since the sub-station was built, and claimed compensation, but the committee informed her that they could not accede to the request.

Fareham (S. Hants).—At the monthly meeting of the Fareham Urban District Council the question as to what course should be taken in consequence of the recent action at law between the Council and the electric light company having gone against the former was considered. It will be remembered that the judgment was that the Council had to pay damages (£3,800) and costs, but time was given the Council to decide whether they would pay up or take over the undertaking. The meeting of the Council was largely attended by the ratepayers, and considerable heat was displayed by them during the debate. The Chairman said there had been a meeting to talk over and decide some line of action. He had told Mr. Blake that he intended to do one thing, and that was, take the wish of the ratepayers, not by public meeting, but by taking a poll of the town. The clerk read a report on the value of the electric light company's undertaking, prepared by Messrs. S. Z De Ferranti and E. Manville, electrical engineers, who expressed the opinion that the undertaking was a losing concern, with no prospect of ever becoming a paying concern. If the local authorities took it over, they considered this could only be justifiably done on the basis of what the plant would fetch if sold by public auction. Under the most favourable circumstances they valued the plant at £1,450, with £300 the cost of obtaining the provisional order. If the plant were purchased by brokers, it would not fetch more than about £750. Messrs. Ferranti and Manville, having assessed each item in the schedule attached to the proposed contract at what they considered a fair trade price, valued the whole thing as a going concern at £3,164, and they could not understand how it was the arbitrators assessed the concern at so high a figure as £4,866. If the Council took the undertaking over, the Board of Trade would be almost certain to order that the wires be put underground, and duplicate machinery provided, whilst the Local Government Board would not sanction a loan for more than seven or eight years. Mr. C. B Smith said the report just read fully justified the Board's action. If they purchased, it would mean a future lighting rate of 1s in the pound, whereas if they refused they would have to pay one rate of 4s. in the pound, but they would get it back in the course of six years in the reduced lighting rates The Chairman then proposed that before deciding whether to pay the damages or to accept the offer made in court by the company to complete the purchase of the undertaking, a poll of the parish be taken as provided by the Local Government Act, 1894, for the election of councillors. The resolution was put and carried. The poll was fixed for December 21, between the hours of 8 a m and 8 p.m., and the chairman was appointed returning officer.

Stafford.—The Estates and Works Committee of the Town Council have recommended that permission be granted to the National Telephone Company, Limited, to affix 16 additional wires to the standard on the Guildhall, as, owing to the transfer of the trunk lines to the Government early next year, the wires would have to be carried to the post office for the public use. Mr. Smallman, in moving the adoption of the report, said the committee had considered as to the lighting in the Market-square, and recommended that two electric arc lamps be erected therein, the two gas lamps outside the Guildhall being entirely dispensed with. The arrangement was that the gas lamps in the square should only be lighted at 11 30 at night, when the arc lamps were switched off, the increased annual charge being £11. 10s. The committee also considered as to the arc lamps in the Gaol square and Foregate street, and recommended that they be taken over as part of the public lighting as from January 1 next, the gas lamps in the neighbourhood being lighted when the arc lamps are switched off; the increased annual charge in this instance would be £27 10s. He added that the present cost of lighting the Market-square was £33. 10s per annum, and that the total extra cost of the new arrangement would amount to £39 yearly The report was adopted. With regard to the proceedings of the Gas and Electricity Committee, the Mayor, Alderman W. H Peach (chairman), and Alderman W. Silvester (vice-chairman) were appointed a sub-committee to confer with representatives of the County Council as to the charge for electricity supplied to the new county buildings. The committee submitted for approval a scale of charges in connection with the supply of electricity: hire of meters, to register 5 or 10 amperes, 5s. per quarter; 20 or 25 amperes, 6s. per quarter; 30 or 50 amperes, 7s. per quarter; making service connections, not exceeding 10 amperes, £2; 25 amperes, £3; and not exceeding 50 amperes, £4 Alderman W. H Peach moved the consideration of the report. With reference to the price to be charged to the County Council for electric light, nothing had yet been arranged. Alderman Goodall seconded the proposition. Mr. Lovatt complained that the charge for electric meters was excessive, and moved that the question be referred back to the committee Mr. F. Amies seconded the motion. Alderman W. H. Peach pointed out that the sum fixed upon was 10 per cent. on the cost, and was based on the same principle of charging as the gas-meters. The charge for making the connections was just about the actual cost to the committee. Mr. W. O. Rooper supported Mr. Lovatt's motion. If the committee wanted the electric light to become popular they ought to make every possible concession, especially in the case of small consumers, who would no doubt regard the charge for meter rent as a very heavy one, and might in consequence discontinue taking the light at Easter until October. Alderman Lloyd hoped that the promise given that the greatest endeavour would be made to make the electric lighting a paying concern would be fulfilled. Alderman W. H. Peach undertook to report to the next meeting of the Council what the charges were in other towns, and the report as amended was adopted.

The Liverpool Overhead Railway Extension.—It is expected that before 1896 begins its course the heading of the tunnel at the South-end for the extension of the electric railway will be driven through the Herculaneum Dock to the Dingle terminus. Only about 60 yards have now to be pierced in order to accomplish this. The extension of the overhead railway will be very different in its character from the original portion. The line that sweeps along the length of the docks of Liverpool is carried nearly every yard of its way upon an iron viaduct a good height above the level of the street. But the extension burrows all the way through the soft red sandstone rock which rises above the Mersey where the south docks have been constructed; and the Dingle terminus,

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which will be adjacent to the Dingle tramcar terminus, will, with the exception of the ticket and station offices, also be beneath the surface. The contracts for the extension were entered into during the earlier part of the present year. Messrs. H M. Nowell and Co., of Leeds, secured the contract for the tunnel; and Messrs. Pearson and Knowles the contract for the viaduct connecting the present line with the tunnel and bridging over the lines of the Cheshire Lines Committee. They are not losing any time in securing the execution of the work within the stipulated period, and the expectation of Mr. Cottrell, the general manager of the overhead railway, is that the public will be using the extension early next summer. The present southern terminus of the railway is at the Herculaneum Dock. The extension begins on the left, about 150 yards to the north of the Herculaneum Station, and bends in a south-easterly direction across the lines of the Cheshire Lines Committee, being carried over these by a lattice girder bridge, 2oft. deep, of one span of 220ft., this being the largest span of a railway bridge in or near Liverpool. There is as yet not much evidence of the bridge, but the material is in a forward state of preparation, and when once the work is begun a comparatively short time will be required to erect it and lay the permanent way over it. The boring of the tunnel by Messrs. Nowell and Co. from that point to the Dingle is being done in sections, and a considerable portion is already cut out to the full size 26ft. by 20ft (to the crown of the arch Shafts were sunk in Shorefields (belonging to the Midland Railway Company), in Parkhill-road in Hurry-street, in Arthur-street, and at the Dingle terminus. and when the requisite depth had been reached headings were driven each way. The headings have all met with the exception of those between Arthur-street and the Dingle, which are now only about 60 yards apart; and as the Shorefields, the Parkhill-road, and the Hurry-street shafts have served their purpose they have been filled up again The enlargement of the heading to the full size of the tunnel is also being done in numerous sections. There will be a brick lining of the arch of the tunnel throughout, and, as the rock is of varying quality, the necessity of starting the lining from the floor of the tunnel, or from the spring of the arch is determined by the engineer and contractors as they proceed. As some evidence of the rate with which the work is being executed it may be mentioned that during last month 55 yards of the tunnel were completed, with the brick lining, etc., and that 200 yards more will have been similarly dealt with during the present month. The excavation at the Dingle end will be 52ft. wide in order to allow spacious platforms to be constructed. The intention of the directors of the overhead railway, the *Liverpool Courier* says, is to construct a new station on the existing line opposite the Wellington footbridge, and to use the end of that line as a carriage shed. The new station will be extremely convenient to the adjacent portion of Toxteth, which is built on the top of the rock, for a footbridge connected with the Wellington-street footbridge will carry them into the station without the descent and ascent of steps that are now necessary. There will be no other station until the Dingle terminus is reached. When the extension is completed the north and south of the populous district along the line of docks will be connected by a splendid and direct line of access, which cannot fail to increase the already great usefulness, as well as undoubted popularity, of the overhead railway.

PROVISIONAL PATENTS, 1895.

DECEMBER 2.

23002. **Improvements in electrical batteries.** Frederick Hanson Perry, 12, Cherry-street, Birmingham.

DECEMBER 3.

23083. **An improved armature for dynamo-electric machines.** Edwin Hodgson, James Walker, and Arthur Blackburn, Whitcliffe, Cleckheaton.

23097. **Improvements connected with the electrical deposition of zinc.** Richard Heathfield and William Stepney Rawson, 1, Leadenhall street, London.

23109. **Improved electric switch for key, socket, main, or ordinary switches.** Walter Mills Close, Hatchford, Cobham, Surrey.

23111. **Improvements in electric incandescent lamps.** Henry Francis Joel and Ferdinand Fante, 1, Arundel-street, Strand, London.

23165. **Improvements in and relating to galvanic batteries.** Audley Charles Miles and Bernhard Fritz de Morgenstern, 151, Strand, London.

DECEMBER 4.

23174. **Improvements in electric arc lamps.** John Hewett, 8, Great Portland-street, London.

23189. **New pantelegraph for transmitting in facsimile autographic telegraphic messages in handwriting, print, sketch, design, etc.** Harry Adrian Schlesinger, as agent for Louis Sandos, 10, rue des Voirons, Geneva.

23250. **Improved paste-carrying plates for electric accumulators.** Friedrich Wilhelm Schneider, 18, Buckingham-street, Strand, London. (Complete specification)

DECEMBER 5.

23259. **An improved reflector for incandescent electric light globes or bulbs.** Samuel Rowbottom and John Roe, 64, Barton-arcade, Manchester.

23338. **Improvements in or relating to electric arc lamps.** Henry James Fisher, 70, Chancery-lane, London.

23354. **Improvements in electric heating devices.** Fernand Le Roy, 6, Lord-street, Liverpool. (Complete specification.)

DECEMBER 6.

23404. **Improvements in electric motors.** Felipe Zapata, 31, Homefield-road, Chiswick, London.

23415. **Improvements in or relating to electric arc lamps.** Moïse Freudenberg, 45, Southampton-buildings, Chancery-lane, London.

23416. **An electric door fastening.** Samuel Flood Page, 28, Southampton-buildings, Chancery-lane, London.

23426. **Improvements in electric signalling.** Reginald Belfield, 31, High Holborn, London.

DECEMBER 7.

23459. **Electro-depositing on and stripping gold from cathodes.** Emile Andreoli, 147, Coldharbour lane, London. (Complete specification.)

23462. **Improvements in the striking and regulating mechanism of arc lamps.** Haldane Gwilt Cotsworth, 14, Station-road, Swindon.

23496. **Improvements relating to electric railways.** Reginald Belfield, 31, High Holborn, London.

23515. **Improvements in the manufacture of electric cables.** Arnold François Borel, 45, Southampton-buildings, Chancery-lane, London.

23519. **Improvements in electrical insulators and insulating compositions** Alfred James Perton Whitaker and Frederick Gwilym Treharne, 45, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1895.

107. **Primary batteries.** Levetus and others.
437A. **Arc lamps.** Barton. (Jandus.)
1906 **Electric condensers.** Threlfall. (Threlfall.)
11728. **Electric switches.** Shaw.
13900. **Galvanic batteries.** Gordon.
19104. **Electric rail-bonds.** Buxton.
19204. **Electric signalling.** Gibson.
19318. **Telephone and signalling systems.** Smith and Vasar.
19461. **Thermo-electric generators.** Cox.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅜-6½
Brush Company, Ordinary	3	1½-1⅝
—— Non. Cum, 6 per cent. Pref.	2	1⅝-2⅛
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5¼-5⅜
Chatham and Rochester	—	
Chelsea Electricity Company	5	6⅞-7⅛
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	12⅜-13¼
—— 6 per cent. Cumulative Pref.	10	15⅜-16¼
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	130-132
—— 5 per cent. Pref. Shares	10	14⅜-15¼
County of London and Brush Provincial Co., Ordinary	10	8¼-9⅛
—— 6 per cent. Cum. Pref.	6	8¼-9
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1⅝-2⅛
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅝-¾
—— 7 per cent. Cumulative Pref.	2	2-2⅛
Elmore's Copper Depositing	2	1-1⅛
Elmore's Wire Company	2	⅝-¾
Fowler-Waring Cables	5	1-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	13¼-14½
—— 7 per cent. Preference	10	15¼-16⅛
—— 4½ per cent. Debentures	100	108-111
House-to-House Company, Ordinary	5	4¼-4½
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	18-19
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge Ordinary	5	7⅜-8⅛
—— 6 per cent. Pref.	5	7-7⅛
Liverpool Electric Supply, Ordinary	5	7⅜-8⅛
Liverpool Overhead Railway	10	11⅜-11⅞
—— 5 per cent. Pref.	10	15¼-16⅛
—— 4 per cent. Mortgage Debentures of £100	100	114-116
London Electric Supply	5	⅞-1
Metropolitan Electric Supply	10	10½-11⅛
—— 4½ per cent. First Mortgage Debenture Stock	100	117-120
National Telephone, Ordinary	5	6⅛-6⅝
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15½-16½
—— 5 per cent. Non. Cum. Third Pref.	5	6⅛-6⅝
—— 3½ per cent. Deb. Stock	100	106-108
Notting Hill Company	10	8¼-9
Oriental, Limited, £1 shares	1	1-1⅛xd
—— £5 Shares	5	7⅜-8⅛xd
—— £4½ shares	4½	6½-6¾xd
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	104-105
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8-8½
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	39-41
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4⅜-5
Westminster Electric Supply, Ordinary	5	8-8½
Yorkshire House-to-House	5	6¾-7¼

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NOTES.

Argon.—The Académie des Sciences has awarded the Lecomte prize of 50,000fr. to Prof. Ramsay and Lord Rayleigh for their discovery of argon.

Theories of Electrolysis.—Under this title Mr. W. C. Dampier Whetham, M.A., Fellow of Trinity College, Cambridge, contributes an article to the current number of *Science Progress*.

Naval Signals.—The sloops "Algerine" and "Phœnix," which are being completed for sea at Devonport, are, it is stated, to be fitted with semaphore electric lights for masthead signalling at night.

Tramways in Persia.—Herr Felix Moral, who is said to represent a syndicate of German firms, has obtained a concession for the construction and working of a steam or electric tramway from Teheran to the villages north of the city, a distance of about 10 miles. The concession is valid for 90 years.

Gas Again.—The Rev. Evan Hurndall, the well-known Congregational minister, and Mrs. Hurndall, were found unconscious in their bedroom at Westminster last Sunday morning, having been overpowered by an escape of gas during the night. Mrs. Hurndall soon recovered consciousness, but Mr. Hurndall remains in a critical condition.

Memorial.—A meeting of Cork citizens has been convened by the Mayor of that city for the purpose of taking steps to perpetuate the memory of the late Mr. Denny Lane, M.A., and it was eventually resolved to form a committee with the view of collecting subscriptions in order to provide a suitable memorial. The Cork Gas Consumers' Company has headed the list with a donation of £100.

Electrotechnics in Chili.—It is stated that the Chilian Government, having decided to establish an electrical section at the Escuela de Artes y Oficios, mainly with the object of familiarising naval engineers with the principles of electrical engineering, has engaged as instructor Dr. Fritz Mumme, late of the Aktien-Gesellschaft vorm. Schuckert und Co., who has departed for Chili accompanied by two working assistants.

New Arc Lamps.—The active movement in the construction of new designs of arc lamps still continues. Lamps with downward burning shadowless arcs (the negative pencil being placed at an acute angle to the positive) are not new, yet a Berlin firm—Niewerth und Co.—seems to have worked a patent on this principle through the once impregnable German Office; and the lamp constructed on their system is described and illustrated in the *Elektrotechnischer Anzeiger* of December 8.

Telephones in Iceland.—The telephone has apparently got a footing in Iceland. It is said that an American is laying a line between Reykyavik and Akureyri at a cost of 100,000 kr. It is also reported that an Englishman has submitted to the Althing a proposal for a telegraph cable between Iceland and the Shetland Islands. The estimated first cost of the latter, 1,800,000 kr., and the annual maintenance charges of 180,000 kr., the contractor believes would be partly covered by Iceland, Great Britain, France, and North America respectively.

Harnessing the Tides.—What is probably the first serious attempt to utilise the energy of the tides is now being made on the Pacific coast at Santa Cruz. A dynamo, to cost about £4,000, is now being placed in position. It will be worked by a head of water raised by the tide, and the electrical energy thus obtained will be employed in lighting the town and in driving the street cars. That, at any rate, is the idea, although whether it can be successfully carried out remains to be seen. The apparatus will be completed, and, it is expected, in full operation, early next month.

Telegraphs and Telephones in the Sahara.—According to the *Kölnische Zeitung*, M. Bayolle, an engineer at the head of a telegraphic expedition travelling from Biskra to Tuggurth, telephoned on November 18 from his camp, 11 miles away, to Biskra. He said that he expected to reach Tuggurth by the middle of December, but that he was experiencing great difficulties with the camels carrying the telegraph poles. The animals were not accustomed to such lengthy burdens, and they frequently lied down in the road and coolly refused to budge an inch with their load.

The American Pacific Cable.—Senator Carter has introduced a Bill into the United States Senate authorising the Pacific Cable Company of New York to co-operate in the laying of a Pacific cable to Japan by way of Hawaii, the United States Government agreeing to pay an annual subsidy for 20 years at the rate of 25dol. per mile on a distance not exceeding 7,250 miles. The Bill also provides that United States Government messages shall be given the preference, that they shall be carried free for 20 years, and that in case of war the line shall be placed in possession of the United States.

Which is it to be?—We observe that the London *Times* has lent the weight of its authority to the word "autocar," which it now prints without the significant inverted commas but with a hyphen, "auto-car." We believe that the vocable originated with a journal called the *Hardwareman*, which succeeded in obtaining the powerful support of the *Engineer* for its offspring. As for ourselves, being linguistic purists, we do not care for hybrid constructions—"auto" is Greek, while "car" is Latin and Celtic. At the same time, such clumsy phrases as "horseless carriages," "mechanical road carriages," and "self-propelled vehicles" are not meeting with general favour. Why not therefore adopt the philogically sound "motor-car," which could be run into a single word, "motorcar"?

The New Atlantic Cable.—A Paris telegram says that the Budget Committee has approved the draft convention concluded between the Government and a French cable company for the laying of a new cable between Brest and New York, with an extension to the West Indies, and thence to Para, in Brazil. The committee declined, however, to sanction M. de Mahy's proposal for a cable between Réunion and Mauritius, their view being that all such schemes should be initiated by the Government. The *Débats* comments on the tenacity shown by Great Britain, despite Brazilian protests, in regard to the possession of the Island of Trinidad, "which will be for her South Atlantic cables what Bermuda is for her North Atlantic ones," and it adds that Mr. Chamberlain is showing an active interest in the scheme for a cable between British America and Australasia, "which will crown the practical cable monopoly possessed by England."

Lightning Freaks.—In South Devon, shortly before 10 o'clock on Wednesday morning, two brilliant flashes of lightning were followed by peals of thunder. In a field near Plymouth, which is used as a rope-walk, an "electric ball" was seen. It is described as travelling from west to east, tearing up the ground for 100 yards in its course until it reached the place where two men and a boy were employed in rope-walking. It shattered the lower part of the door of a small house occupied by the spinning wheel, knocked a hole in the wall on the opposite side, and then, passing upwards, partly unroofed an adjoining building. It next passed along another rope-walk where four men were working. One of these, named William Morey, was unfortunately instantly killed, and two others were knocked

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down. One, named James Lowe, was seriously injured, and his condition is described as critical. Fishermen report that on Monday night, while they were at sea, they observed "fireballs" in their masts and rigging.

Progress in Electric Lighting.—At the monthly meeting of the architectural section of the Philosophical Society of Glasgow, Mr. David Hunter, a member of the Institute of Mining Engineers, read a paper on "Progress in Electric Lighting." He showed first light from acetylene gas obtained from the new compound calcium carbide, made from a combination of lime and coal dust fused together in an electric furnace, and proceeded to say that Nature was economical in all her methods, but in man's method of burning coal a ridiculously small part of the energy was converted into light. The energy delivered from coal by means of an engine to a dynamo was only 3·62 per cent., and the efficiency of the latter was such that about 78 per cent. of that was delivered to the consumer. The present incandescent lamp was very inefficient and wasteful, great part of the energy going into heat. The most difficult problem in lighting a considerable area was the distribution of the current energy among the consumers.

The Wiring Question.—Our contemporary the *Builder* has now taken up the wiring question. In the course of an article it says: "Electricians are beginning to realise that wood casing is by no means a perfect way of conveying electric wires to lamps in house wiring. We have often had occasion to point out that this method is very unsightly. There are many hotels and other buildings which have been wired without the slightest attempt at preserving appearances, as if getting at the place where the lamp is to be fixed by the shortest route over moulding and cornice was the main consideration. Again, where the wood casing is concealed there is often a reckless cutting at joints by the so-called wiremen, to the possible weakening of the building. To guard against this, architects should always make ample provision in the way of conduits or channels for the electric light or power wires. It would be a great boon to fire insurance inspectors, as at present any inspection of electric wiring after it has been closed in by lath and plaster is of no value."

"The Fruits of Monopoly."—A correspondent writes under this head to the *Times*: "Some weeks ago I wrote to the National Telephone Company and requested that they would connect my house with the exchange with as little delay as possible. The manager replied that the work could not be finished under about six weeks, in consequence of some alleged difficulty about 'wayleaves' in the part of the town (Belgravia) in which I reside. I thought the delay unreasonable, but having, of course, no option, I gave the order to proceed. At the end of eight weeks there was still no sign whatever of my telephone, and, tired of waiting, I countermanded the order for it, and am instead connecting my house with the District Messenger system, which, if less convenient than the telephone, will to some extent supply the place of it, and will anyhow be installed without unreasonable delay. I have lately come from a country where the convenience of the public is a matter of first consideration, and I am inclined to think that, under the wholesome influence of competition, eight days, let alone eight weeks, would have sufficed for the work in question." Comment is needless.

Artificial Rubbers.—A substitute for indiarubber has been devised by M. E. Desprez, of Paris. Guttapercha in sheet form is taken and covered on one side or both sides with a close-meshed fabric (wire gauze may be used for some purposes) and the whole is conglomerated by pressure under heat, and sawdust or other suitable and cheap substances may be incorporated. An artificial rubber of more or less strength may also be obtained by dissolving four parts of nitro-cellulose in seven parts of bromo-nitro-toluol. Upon varying the proportion of the nitro-cellulose, a material may be obtained that possesses elastic properties and closely resembles indiarubber and guttapercha. If desired, nitro-cumol and its homologues may be used instead of bromo-nitro-toluol. As the base of a product designed to replace indiarubber and guttapercha, M. Le Brocquy, says the *Revue Scientifique*, proposes to employ the composition used for making printers' rollers—that is, a mixture formed of variable proportions of glue, glycerine, and molasses. This composition is to be covered with canvas, ordinary rubber, or any other material suitable to protect it against humidity, great heat, or any mechanical action.

The Cantor Lectures.—In his third and last lecture on "Mechanical Road Carriages," delivered at the Society of Arts on Monday night, Mr. W. Worby Beaumont discussed some of the recent developments of the subject. After referring to the interest taken in these road carriages in France, he remarked that in England legal restrictions had kept down an industry in which we ought to be a long way ahead of France, instead of being a long way second, seeing that 60 years ago Englishmen proved practically that steam road carriages could be made a commercial success. He then mentioned some of the motors more recently employed to drive these carriages, describing the oil motors of Butler, Knight, Daimler, and Benz, the electric cab and omnibus of the Radcliffe Ward Company, and the successful steam motor and boiler of Serpollet. Some of the points that should be borne in mind by the designer of road carriages were next touched upon. If we made light carriages that required both a driver and a stoker, our machines would be inferior to those of the French. The vehicles must demand little skilled attention if they were to be generally used. It was a question whether high speeds were necessary, and it was no good to make machines with a capacity for high speed which could not be utilised.

The Rating of Telephone Wires.—On Monday last the special sessions for South London sat at the Newington Court House for the purpose of hearing the appeal of the National Telephone Company against the valuation lists of the parishes of St. Mary, Newington St. Saviour's, Southwark; and St. George-the-Martyr. Sir George Morrison, who appeared for the National Telephone Company, said there had been no legal decision as to the principle on which telephone wires should be rated; but the local authorities had hitherto apparently valued the wires on the mileage, which was not applicable to a business of this nature at all. Mr. Horace Avory (with whom was Mr. Bassett Hopkins), on behalf of the three parishes, produced evidence to show that there was no other way of arriving at the value than by taking the mileage. At the quinquennial valuation in 1890 the Assessment Committee had put the assessment at 30s. per mile, but, in view of the increase of business, it was in 1895 made 49s. per mile, and he contended that it ought to have been a great deal more. The case occupied the whole day, and the Court dismissed the appeal without costs, as important questions of principle were involved. Sir George Morrison stated that as this rating applied to the whole of the United Kingdom the company would consider whether they should appeal to a superior Court.

The Pingault Electric Pacemaker.—M. René Arnoux, at the meeting of the Société Internationale des Electriciens on December 4, described the Pingault electric pacemaker bicycle. In view of the paper of M. Arnoux there was a larger attendance than usual. The bicycle, the constructor of which is M. G. Richard, has

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been designed with the view of improving the pacemaking on track runs where the pacemakers have to be changed every few laps, with the result that the pace is altered at every change. Riding the Pingault cycle, one man can make the pace for an hour at a stretch at speeds up to or beyond 50 kilometres (31 miles) an hour. The machine is driven by the rider in the usual way by pedals and chain, but an auxiliary source of power is provided by two electric motors behind the saddle. These motors are both mounted on the same shaft, and drive a wooden wheel acting directly on the pneumatic tire, an arrangement which obviously permits of an exceedingly great angular velocity in the motors. The current is derived from accumulators carried in a box mounted in the frame between the rider's legs—apparently very much in the same manner as a travelling-bag. The accumulators are split up into four batteries, any or all of which can be switched on according to the speed desired. The switch is on the handle bar, but no details of the accumulators are given, though it is stated that they give 25 watts per kilogramme (11·3 watts per pound). The total weight of the machine, including the accumulators, motors, and fittings, is 90 kilogrammes (about 200lb.), but this has been somewhat reduced in a later design. As *L'Industrie Electrique* (December 10) remarks, the practical application of the accumulators used by M. Pingault will be awaited with impatience if they can maintain the efficiency above stated.

The International Congress of Applied Chemistry.—The first meeting of this body was held in August of 1894 at Brussels and Antwerp, and the second has been arranged to take place in Paris next year under the patronage of the French Government, and will be accompanied by an exhibition of chemical and agricultural industries organised by a separate committee. The congress will be divided into 10 sections, of which the last, Section X., is devoted to electro-chemistry, and will be presided over by M. Moissan, membre de l'Institut. The secretary is M. Gosselin, of the Ecole Centrale des Arts et Manufactures, and among the vice-presidents are MM. d'Arsonval, Hospitalier, Javaux, Mascart, etc. The following is the programme of subjects to be discussed: 1. The laws of electrolysis, with the determination of the constants involved (the resistance of electrolytes in solution and in a state of fusion, the effect of temperature, the E.M.F. of polarisation, etc.). 2. The use of electrolysis in analysis. 3. (*a*) The preparation and use of insulating materials, including indiarubber, guttapercha, and their substitutes; (*b*) the resistance, temperature coefficient, and electric properties of alloys. 4. Electrolysis in the alkali trade (chlorate of potash, soda, bleaching powder, etc.). 5. The use of electrolysis in organic chemistry (rectification of alcohols, sugar manufacture, sterilisation of impure water, synthesis of organic compounds, etc.). 6. Electrolysis of metals in the wet way. 7. Electrolysis of fused salts (sodium, magnesium, silicon, lithium). 8. The electric furnace (carborundum, calcium carbide, silicon boride, titanium, etc. 9. Thermo-electric work (welding, electric heating, etc.). The address of the treasurer of the congress is 156, Boulevard Magenta, Paris, and the fee for admission is 10fr.

Gas v. Electric Light.—The correspondence on this subject in the Kentish papers between residents of Tunbridge Wells and Hastings, with an occasional letter thrown in by secretaries of incandescent gaslight companies in London, continues with unabated energy. A Tunbridge Wells correspondent, who signs himself "Economy," sums up the case against the incandescent gaslight so neatly that we cannot refrain from quoting a portion of his letter. He says: "I have been somewhat surprised and amused at the trouble and expense the supporters of the ancient illuminant 'gas' have gone in this town to endeavour to upset the Corporation electricity scheme. I regret in many cases the opposition has been nursed by worthy members of the Council, who are elected by the ratepayers to study their interests. Undoubtedly, they must have overlooked this fact in their eager desire to protect their own, to the disadvantage of the former. However, I for one would be sorry to stop them, since they are really doing all they can to help the scheme by giving it a free advertisement, since any intelligent reader would reason thus: 'Another letter against the electric light! How frightened all those who have an interest in our local gas company seem to be, and for what reason?' The answer is clear: because they know the electric light is much superior to gas, and no more expensive; otherwise, why should they trouble themselves? However, at the present time there is no need for the gas company to be alarmed, as they are bound by the laws of progress to give way to the superior illuminant. It would be more sensible for them if, instead of 'kicking against the pricks,' they were to spend their surplus energy in looking for other sources to obtain their income. The time is not far distant when that income derived from cooking, heating, and gas-engines will also be swallowed up by electricity. Already electric cooking and heating stoves, as well as electric motors, are being installed on account of their convenience and cleanliness. The 'incandescent gas' may be considered one of the stepping-stones between an ordinary gas-burner and electric light, as there is nothing more sure to eventually lead to the adoption of the modern illuminant than installing the incandescent gas. The fact of a consumer changing to it shows his dissatisfaction for ordinary gaslight, but, being more or less conservative in principle, he does not like to effect a radical change all at once, and therefore puts in the 'incandescent gas,' to follow at some future time with the electric light, whereas he might have saved himself the preliminary expense. I have been often puzzled over the policy adopted by the various gas companies in persuading their clients (and in many cases effecting the necessary change free of cost) to adopt the incandescent gas, which is in direct opposition to their own interests, since according to their statement it consumes less gas, and gives more light than an ordinary 16-c.p. burner, or, in other words, reduces their own income considerably! Their clients ought indeed to be thankful for their philanthropic motives! They might go further, and inform them of its little eccentricities, such as the mantle breaking with a breath of air, or on lighting it with a match, necessitating the use of a by-pass which burns gas all the 24 hours. This prevents a timid consumer from turning his gas off at the meter every night (a very wise precaution in case of fire), and last, but not least, the rapid rate at which the brilliancy vanishes as the age of the mantle increases, meaning the replacing of the same frequently. They might also recommend it to the fair sex for its peculiar greenish hue."

The Accumulator Question.—The first trial by the American Institute of Electrical Engineers of the feature of topical discussion, remarks the New York *Electrical World* of November 30, was an unqualified success, and it will, most probably, regularly figure hereafter on the yearly programme. The several communications read at the institute meeting, and the discussion which followed, undoubtedly form the best contribution yet made in America to the practical side of the subject of storage batteries. The papers of Prof. Crocker and Mr. Childs resume in detail the various uses to which they are

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applicable, the former adding also the disadvantages, and the latter giving much information on points of practical interest. Mr. Hering's remarks bring out the advantages of the Planté type of cell, and refer more particularly to traction batteries, in regard to which he discusses the important question as to the relation which should exist between the life of a cell, its cost and weight, in order to attain the most economical service. Those who complain that the storage battery has been too much coddled, and that reference to any of its faults has been considered in the light of *lèse majesté*, will find no reason to complain of the treatment accorded it by Mr. Perry, who argues that the gas-engine is more economical for many purposes for which the storage battery has been claimed to be exclusively applicable. It is undoubtedly true that the gas-engine has been neglected in the United States, and that it has a most promising future everywhere. The fact remains, however, that in Germany — where the gas-engine has received widest adoption and its advantages are most clearly recognised, and where, moreover, the question of central-station auxiliaries has been most carefully studied— the storage battery has not been appreciably affected by its competition. The favourable testimony borne by Mr. Edgar as to the advantages of storage batteries in central-station work is particularly effective on account of being based upon actual experience. While the results that have been obtained in Europe should cause no doubt to be entertained as to the economy that may be obtained from their use in this connection, yet the lack of experience under the conditions of American practice has discouraged interest in the subject. With the satisfactory results gained at Germantown, Merrill, Wis., and Boston, details of which are now accessible, central and power station managers are brought face to face with the situation, and can no longer afford to delay investigation as to how it affects their interests. In the discussion our contemporary notes that in one place the storage battery was spoken of as having an ampere efficiency of 96·1 per cent., and a watt efficiency of 84 per cent. The absurdity of speaking of ampere efficiency is so generally recognised that it is surprising to find the term employed in a discussion before the American Institute of Electrical Engineers. While perhaps all of those at the meeting know that the term carries no real significance whatever, if used, however, in presenting the subject of the storage battery to others of less technical knowledge, the result will merely be to excite suspicion with respect to other statements. For it is not difficult to conceive that if an intended purchaser, not knowing the distinction, is told that a battery has an ampere efficiency of 96 per cent. and a watt efficiency of 84 per cent., he will not be favourably impressed by the double statement, and may be inclined to believe that there are perhaps still other efficiences on the descending scale of which he is not told. The only efficiency that should be used, our contemporary adds, is the one which denotes the ratio between the energy taken out of a battery and that put in—the watt efficiency—for that is the only practical, as well as the only true, efficiency.

Electrical Communication with Lightships.— It was an interesting tale that Mr. Hobbs, of Ramsgate, unfolded at the public meeting which was held at Deal the other day in favour of electrical communication between the Goodwin lightships and the shore. Mr. Hobbs said that he advocated such means of intercourse 14 years ago. At that time he was looked upon as a madman, and the authorities treated him so, and he holds a letter from Lloyd's showing that they would not allow his petition sheets to lie on their table for signatures. Again, he had a crowded meeting at Ramsgate, and the sailors there were disgusted with his idea. They said it was impossible, and that nobody but a madman would propose such a thing. He told them it would be done, but they amused themselves by pelting the good chairman (Sir George Bonner) with peas. They, however, passed a unanimous resolution and got up a national petition, and it was presented by Lord Brassey on August 2, 1891. He had to see several members of the Cabinet, and happened to meet Mr. Fawcett. "What, electrical communication! Why it is the very thing we want," he said. "Come with me, and I'll take you to see Mr. Chamberlain." Mr. Hobbs thereupon had a long interview with that gentleman, who, after having explained to him the circumstances of four wrecks, ejaculated, it is said, "Why, I never understood it like this before. Forward the petition, and I will do my very best for you." Mr. Hobbs remarked that if all the members of the Cabinet and of the Board of Trade had about six hours on the Goodwins, he would be bound to say they would shriek for the communication till they were hoarse. He then went down and saw Sir James Douglas, engineer to the Trinity, who said Mr. Chamberlain had been down, and that they were in earnest, and he said he would do what he could to help him. They eventually got the report of the Board of Trade Committee (who laid the cable from Walton-on-Naze to the Sunk Lightship), and the Right Hon. Mr. Akers-Douglas helped him nobly in the House of Commons by putting questions, presenting petitions, and advising him. Finally, the Board of Trade declared that they would connect the four Goodwin lightships in six weeks, and he had the estimate before him, showing that they were in earnest. Nobody knew how Colonel King Harman was hurt when he came to Ramsgate to announce to him (Mr. Hobbs) that the committee had made up their minds not to connect the lightships on the ground that it would cost too much! The speaker then referred to a plan of Denmark, dated seven years back, showing that the whole of the northern coast of that country was connected by electric cable. He asked his audience, in the name of common-sense, whether it was right for England, the largest maritime country of the world, to be kept behind by red-tapism. Some two or three years ago a Royal Commission was appointed to investigate the matter, and through their influence and recommendation, and the assistance of the two Governments in voting the money, they now had 52 lightships and lighthouses connected out of 244. The Postmaster-General allowed them to send a message from any of the 52 lightships to the shore for 10d., and then they had to pay the ordinary expense for transmission on the land. They now asked the Postmaster-General to accede to their request to allow any message to be sent—by all means pay the men for sending them. They would see, Mr. Hobbs said in conclusion, what a revenue could be obtained when the Blue-book told them that since the experiment was tried at the Sunk Lightship nearly 30,000 vessels had signalled in passing. In the end the following resolution was unanimously carried: "That this meeting is convinced that there is annually a great loss of life and property arising from the want of sufficient communication between the several lighthouses and light-vessels and lifeboat stations situated round the coast of Great Britain, especially between the Goodwin Sands lights and the shore, and that it is a matter of urgent necessity that electrical communication should be established between all the Goodwin light-vessels and the shore, in order to send messages to those ready to come to the rescue of all who are likely to perish."

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WALSALL ELECTRICITY WORKS.

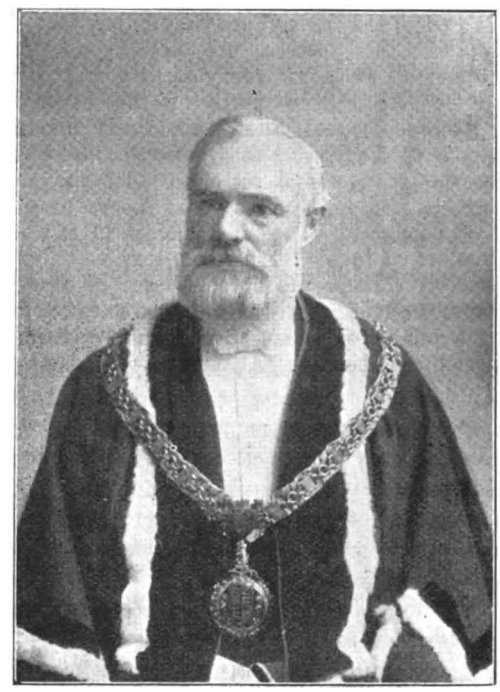
The history of the electric lighting movement in Walsall extends back as far as 1882. In that year a company from Birmingham obtained powers under the Electric Lighting

MR. JOSEPH NOAKE, J.P., MAYOR.

Acts then in force for supplying the town of Walsall, but, as was the case in nearly all the companies started about that time, no work was done, and the powers consequently lapsed. In 1890 the Corporation applied for and obtained a provisional order, and decided to retain Mr. F. Brown as their electrical adviser. Mr. Brown accordingly, in 1891, prepared a scheme for lighting the central parts of the

MR. J. R. COOPER, TOWN CLERK.

borough, and allowed for sufficient plant to maintain about 6,000 8-c.p. lamps alight at one time. About this time the electric tramway was being equipped by the South Staffordshire Tramway Company. The supervision of the work on behalf of the Corporation was also placed in Mr. Brown's hands. This necessitated a visit to America to inspect the electric lines working there. Early in 1892 the report and scheme for electric lighting were laid before the Council, and, finally, tenders asked for. The matter, however, did not proceed much further till the end of 1893, when amended tenders were sent in. At the



MR. T. P. BROWNHILL, EX-MAYOR, AND CHAIRMAN OF COMMITTEE.

enquiry held before the permission to borrow the necessary money was granted by the Local Government Board, it was stated that the population of Walsall stood at 75,000 according to the most recent estimate, and was rapidly increasing. The estimated ratable value was £151,210. In the scheme, the area of supply was the whole of the borough. The borough is of a very scattered character,

MR. F. BROWN, CONSULTING ELECTRICAL ENGINEER.

the total length being about seven miles, and an average breadth of about three miles. There are over 60 miles of public highways inside the boundaries. There was then no application before the Corporation from any person or company within the area to provide electric lighting. Mr. Frederick Brown had then been called in by the Corporation as consulting engineer. It was his advice, after having inspected some of the chief electric lighting stations in

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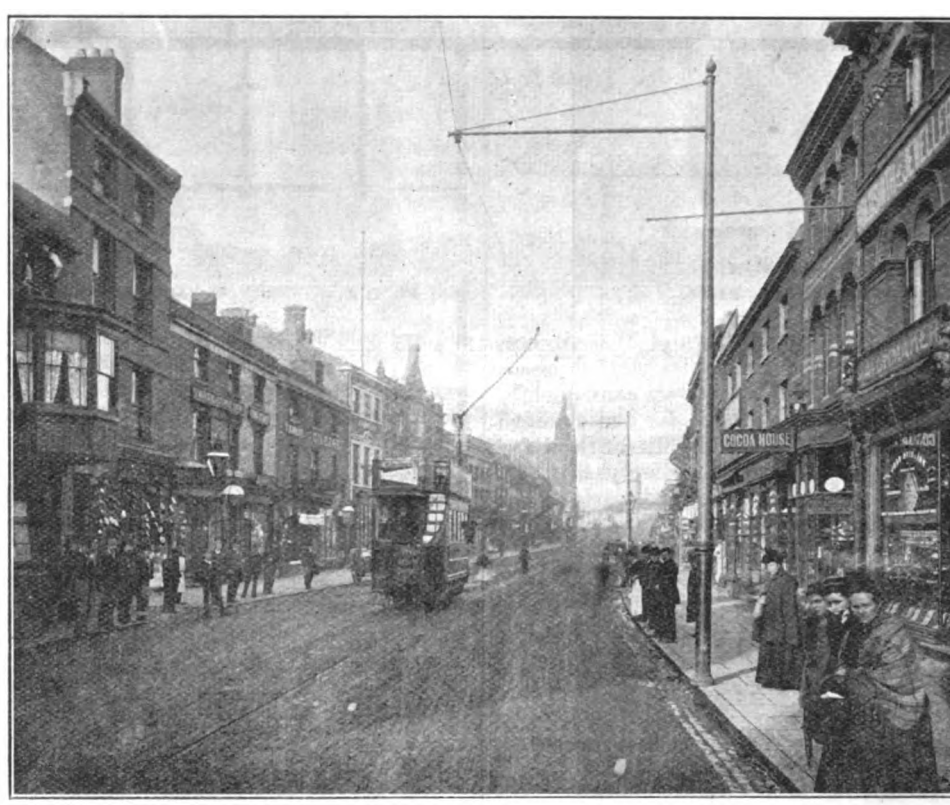
London and the provincial towns, that the continuous-current high-pressure system was best adapted to the town of Walsall.

Owing to the large area within the boundaries of the borough, a high-tension system must be used. For instance, the district of Bloxwich, lying to the north of the borough, is practically another town, containing about 12,000 people. In all probability there will be a demand made for a supply from that part of the borough, as we understand that the inhabitants of this district are not at all backward in their demands to have every facility and advantage possessed by the central parts of the borough. Mr. Brown, having decided that the direct-current high-tension system should be used, spared no trouble in designing the station and mains so that the first cost should not be too high nor should be reduced at the expense of efficiency. The chief points of advantage of this system are as follow: A widely-scattered district can be supplied, as voltages up to 2,000 can be used without trouble from the generators. Accumulators can be installed in a certain number of the sub-stations to supply the lightly-loaded periods of the day. At night, at all times except at maximum load, the generating station can charge the accumulators and supply the current required for the lamps on the mains at the same time. In this way, by adding the charging current to the lamp current, the supply station can be worked at fairly constant load, and hence more efficiently than with some other systems. Again, at heavy loads the accumulators in the sub-stations can be used to assist the continuous-current transformers. Perhaps the greatest advantage of this system over the high-tension alternating-current is that generating stations need not be worked more than eight hours a day, except, perhaps, in mid-winter, hence two shifts of men are saved. On the other hand, low-tension mains must be laid everywhere the demand arises, as isolated houses cannot be economically supplied from a high-tension distributing main. Thus low-tension mains will have to be laid throughout the scattered residential districts.

Site and Building.

As to the site of the works, the Corporation decided to appropriate part of the site of the Wolverhampton-street gasworks. Up to the present time the town has been supplied from two gasworks, both belonging to the Corporation—one at Wolverhampton-street, which is an old works established some 40 or 60 years ago, and the other a modern works at The Pleck, about 20 years old. The Corporation have abandoned the Wolverhampton-street works for the purpose of the manufacture of gas, but still use them as a storing station. About 2,370 square yards of this site is appropriated for the electric light department, and a more suitable position could hardly be found. It adjoins the canal, as can be seen from Fig. 1, and hence coal can be delivered direct to the wharf. Water from the canal will also be taken for condensing purposes as soon as the jet condensing plant is installed. The Local Government Board fixed the price to be paid to the gas department for this site at £90 per annum. Mr. R. H. Middleton, A.M.I.C.E., the borough engineer and architect, took the task in hand of remodelling the old buildings on the site to make them suitable for the reception of the electric lighting machinery. The old retort-house was used for the boilers, and a new roof was added to the adjoining building, which now contains the generating machinery. A section of this building is shown in Fig. 2. The rooms to the left are used as stores, men's room, test-room, etc.,



VIEW OF PARK STREET, WALSALL.

and beyond these, again, there is a tank-room, which holds the large iron tank for the feed water. The inside appearance of these renovated buildings forms a most striking contrast to the exterior views. Some idea of the appearance will be gathered from the perspective views of the engines and boilers. A dado of glazed and different coloured bricks has been built into the walls, and arranged with pleasing contrasts. A good top light has been provided by lights in the roof. A travelling crane, by Messrs. Tangyes, Limited, traverses the whole length of the engine-room, and is supported on long I-shaped girders resting on stone brackets let into the walls. Ample foundations were secured without a great deal of difficulty. The floors of the engine and boiler rooms are of wood blocks. The general arrangement of the plant and buildings can be seen from Fig. 1, and also the ample space provided in the buildings for extensions. The shaft used is also an old one, built for the gasworks, but it is sufficiently large to serve the electricity works for some years. The space between the present boilers and the engine-room has been left for condensing plant. There is also plenty of room for an economiser, to be placed outside the boiler-house at the

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base of the shaft. We must congratulate Mr. Middleton and his able assistant (Mr. R. J. Angel) on the transformation they have effected while successfully adapting the old means to the new end.

Steam Generating Plant.

The contract for the boilers was placed with Messrs. H. and T. Danks, Limited, of the Crown Boiler Works, Netherton. This firm has supplied two of their Lancashire type of boilers, which can be seen in the view of the boiler-house, Fig. 3. Each of these boilers is 7ft. 6in. diameter and 30ft. long, and contains two furnace tubes 3ft. diameter at the firing end and 2ft. 7in. at the other end. No cross-tubes were used, as it is contemplated that the canal water may be used sometimes, and then the cross-tubes would add to the difficulty of keeping the boilers clean. There are two longitudinal stays (Fig. 4), 2in. diameter, connecting the end plates, the screwed ends of the stays being swelled out and screwed 2¼in. diameter. These boilers are constructed to work at 160lb. pressure, and are fitted with a dead-weight safety-valve, a compound safety-valve, main steam-valves, blow-off cock, etc. These boilers and fittings were tested and passed by the Scottish Boiler Insurance Company, Limited. Two feed-pumps of the Worthington type are at present installed, each capable of feeding both boilers when working a maximum load. They are seen in position in Figs. 1 and 4, and are so connected that they can feed either from the exhaust-steam heater or direct to the boilers. The steam and feed pipes to these are arranged in duplicate to prevent all chance of a total breakdown. The town water is used for feed purposes at present, and is stored in the tank referred to above. It is contemplated that the canal water may be used, and a centrifugal pump, driven by a small Crompton motor, is placed in the tank-room for lifting the canal water up to the tank level.

The exhaust feed-heater is of the Brown-Berryman type, made by Messrs. Joseph Wright and Co., of Tipton.

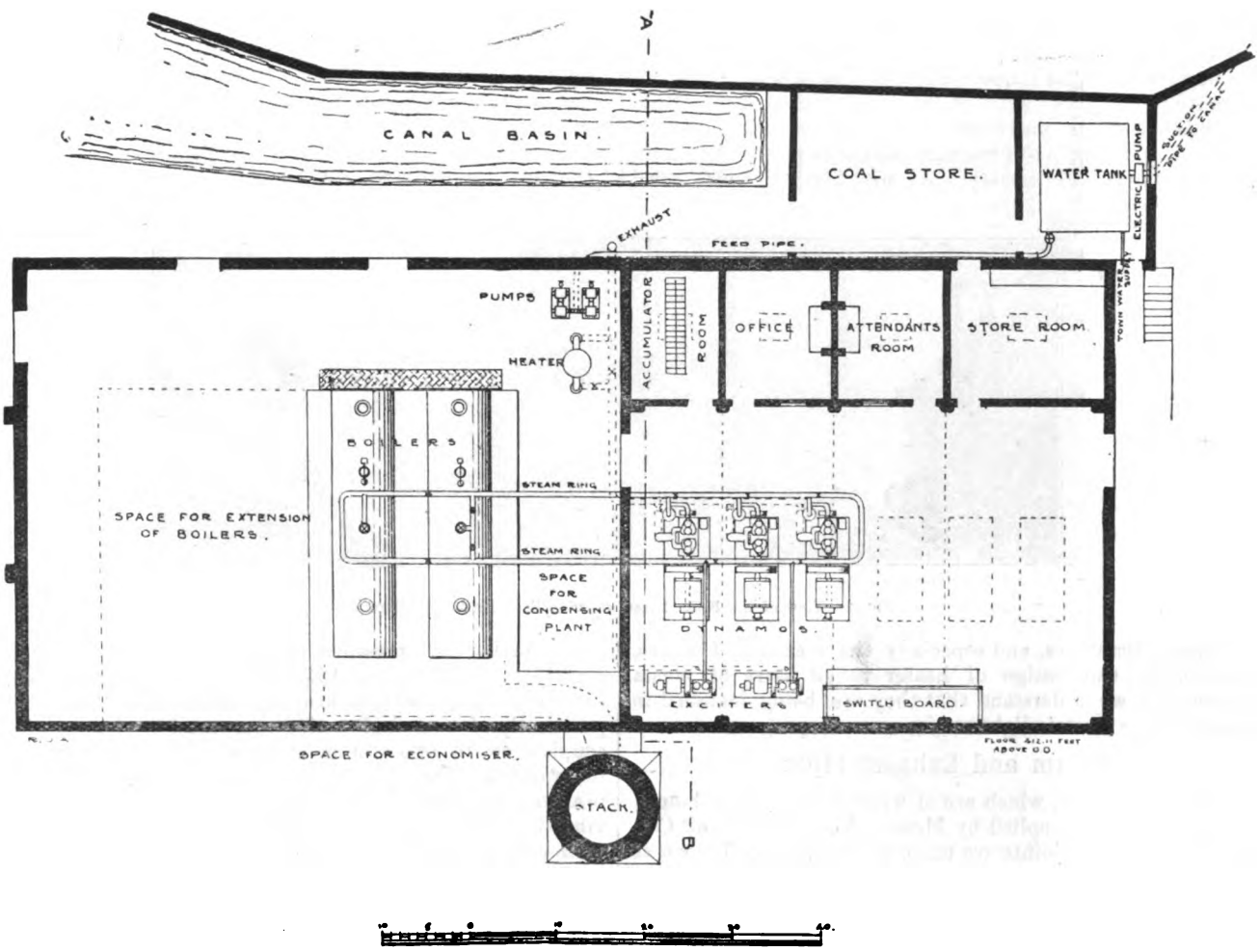

FIG. 1.—Plan of Walsall Electricity Works.

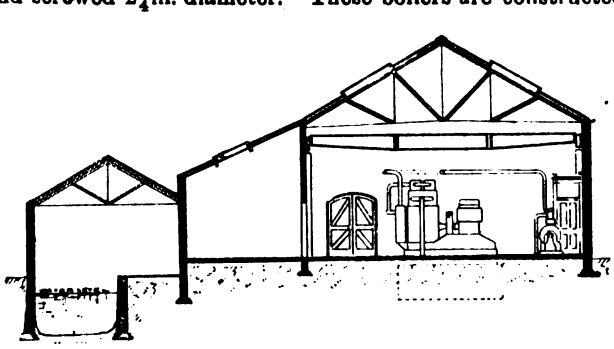

FIG. 2.—Sectional Elevation on the line A B.

The heater (Fig. 4A) contains several improvements brought out and patented by Mr. C. J. Brown which add to the general value of the heater. These exhaust steam feed-heaters require a considerable amount of cleaning if ordinary water is used for the feed, as the greater portion of the deposit is thrown down in them, instead of in the boilers, which saves the boilers considerably. The dirt and lime salts fall to the bottom of the heater and tend to accumulate round the tubes upon a horizontal tube-plate. Often starting from this accumulation, a formation of scale, hard or soft, according to the nature of the water, climbs up the tubes and destroys their efficiency for water heating when such horizontal tube-plates are used. To assist the easy removal of these deposits and incrustations, the above heater was designed by Mr. Brown. As will be seen by the section, the tubes are all fitted into a cylinder at the base of the heater, thus leaving the bottom clear, so that the deposit settles on the dished cover. This dished plate can easily be removed when cleaning is required, and thus afford clear access to the tubes. The annular space into which the ends of the tubes enter is divided into two halves. The steam from the exhaust-pipes then enters in one half, passes through the tubes to the other, and thence out to the atmosphere. The outer cast-

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ing which bounds this space, and contains the inlet and outlet flanges, is so designed that it can be detached and lifted up over the body of the heater. This affords a ready access to the ends of the tubes should they need inspection or repacking. A mud-cock is fixed in the front in the usual way, from which the mud can be blown out two or three times a day. The tubes, which are of solid-drawn brass, are free to expand and contract with the varying temperature, being only held at the ends.

discharged into the atmosphere by the canal wharf shown in the ground plan.

Generating Plant.

The present plant (Fig. 5) consists of three 80-kilowatt Parker dynamos coupled direct to 120-h p. Bumsted and Chandler engines and two smaller exciting sets, also direct driven.

The engines of the larger sets are of the compound

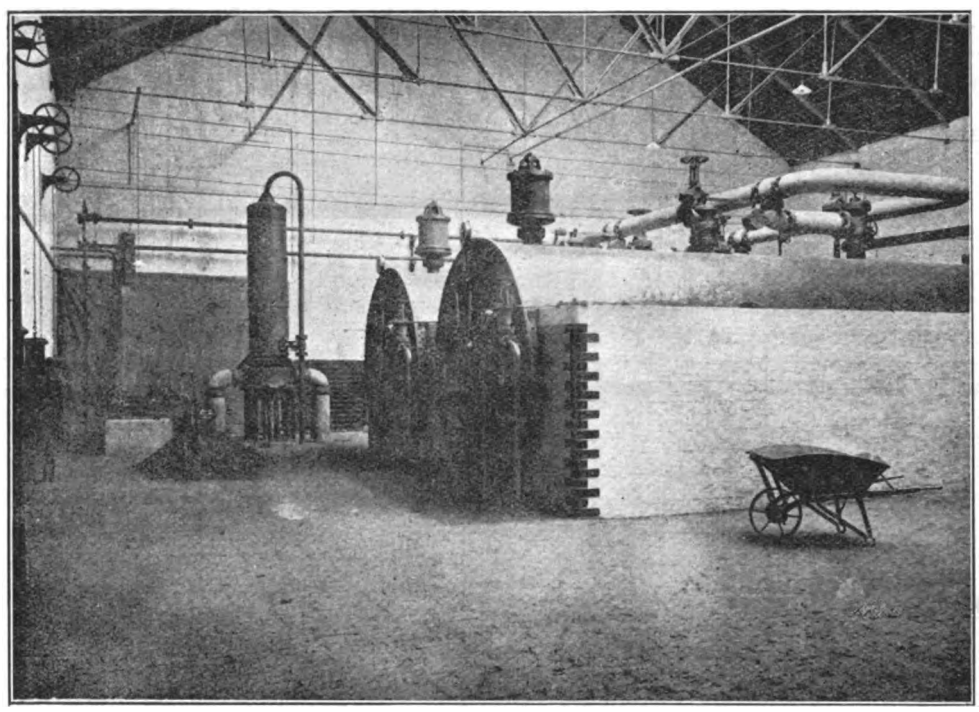

FIG. 3.—View of the Boiler-house, showing Feed Heater and Pumps.

These advantages, and especially the freedom of access, recommend this design of heater to all users of steam power, and we understand that they are being installed in many of the electric light stations now in progress.

Steam and Exhaust Pipes.

The steam-pipes, which are of wrought iron, with flanges welded on, were supplied by Messrs. John Russell and Co., of Walsall. The joints are made on the system known as the copper and asbestos combination joint. The ring

type, having low-pressure cylinders 15in. diameter and high-pressure cylinders 10½in. diameter. The speed of these engines is 350 revolutions per minute. They consist practically of two single-acting compound tandem engines, coupled on to two cranks at right angles. The moving parts in these Chandler engines are all in constant compression, and hence keep the engines free from knocks and vibration. The valve gears are arranged in cylinders at each end of the engine, the valves being of the piston type. The pistons, valve rods, glands, and stuffing boxes

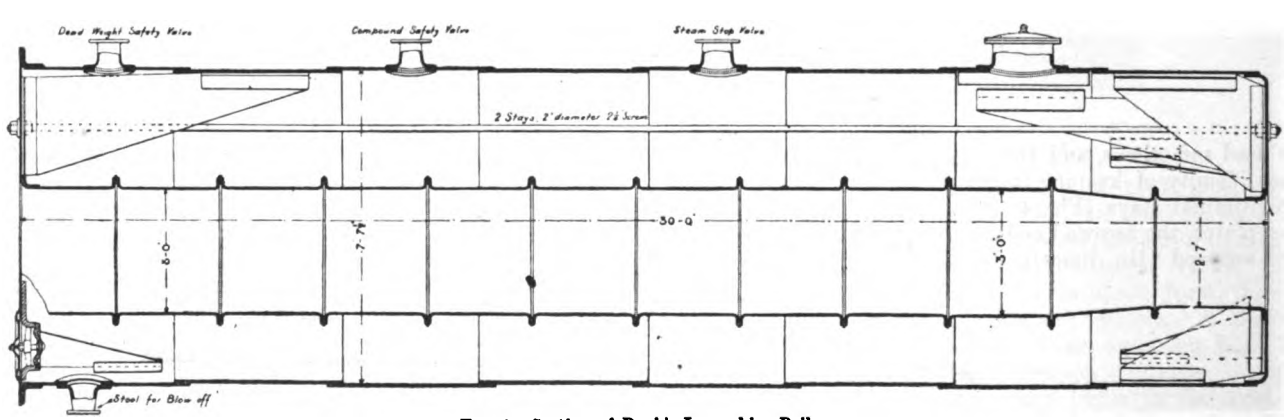

FIG. 4.—Section of Dank's Lancashire Boiler.

system of steam-pipes is used, and the general arrangement of the pipes, with the method of supporting, can be seen in Figs. 3 and 5. The ring extends directly over the boilers, which are connected one to each side of it. The whole of the valves are of Hopkinson's make. The pipes in the engine-room are supported on three vertical pillars, with rollers at the bearing surface to allow of lateral movement as the pipes expand.

The exhaust-pipes are of cast iron, and were supplied by Messrs. Lambert Bros., of Walsall. They are placed below the floor-level in spaces left round the foundations. The exhaust steam, after passing through the heater, is

under the cylinders of these engines are not subjected to steam pressure, and hence seldom require repacking, and the wearing of the brasses of the moving parts give little trouble. The engines are so designed that the crankshaft can be taken out from either end of the crank-chamber. Four covers are provided, two at each side, so that when all are taken off the working parts are most accessible. A good flywheel governor is attached to the outside end of shaft, which holds the engines well in hand. The variation of speed between no load and full load is only 2 per cent. The cranks dip into water and oil at every revolution, and hence are efficiently lubricated. Each engine is also fitted

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with Winn's patent up-drop sight-feed lubricators of the latest type, having coil condensers. The two smaller engines used for the exciters are each of 15 h.p. The high-pressure cylinders are 4in. diameter, and the low-pressure 5¾in. diameter. These two engines run at a speed of 550 revolutions per minute. All these engines exhaust into the atmosphere at present, and run most satisfactorily.

The dynamos were all manufactured by Messrs. Thomas Parker, Limited. The 80-kilowatt two-pole machines (Figs. 6, 7, and 8) are designed to give 40 amperes at 2,000 volts when running at 350 revolutions per minute. They are drum wound with the patent Eickemeyer system, so largely used by Mr. Parker. This system is especially useful with high-voltage machines, as each section is wound separately on a former, and insulated before being put into position. The field magnets are of cast steel, the two limbs and yoke being one casting. This casting, however, terminates on the horizontal plane through the axis of the armature. The two other portions of the pole-pieces are separately attached to the brass supports, so that all the upper portions of the field magnets with the shunt windings can be lifted off, leaving the armature exposed *in situ*. The field magnets are separately excited by smaller dynamos provided for the purpose, or from a set of accumulators in the station should the small sets be standing. The high-tension terminals are shielded by plate glass, to prevent accidents by workmen touching them when attending to the machines. The commutator connections are made to the bottom of the cross-windings, so that the brushes are approximately horizontal. Three 1in. brushes are used at each pole to collect the current, and the machines when adjusted for lead run quite sparkless. The lubrication of these larger sets is carried out by means of a small pump, the plunger of which rests against an eccentric on the shaft. The oil in this case is delivered at the top of the bearing in through a sight-feed lubricator. These dynamos are mounted on the extensions of the engine bed-plates.

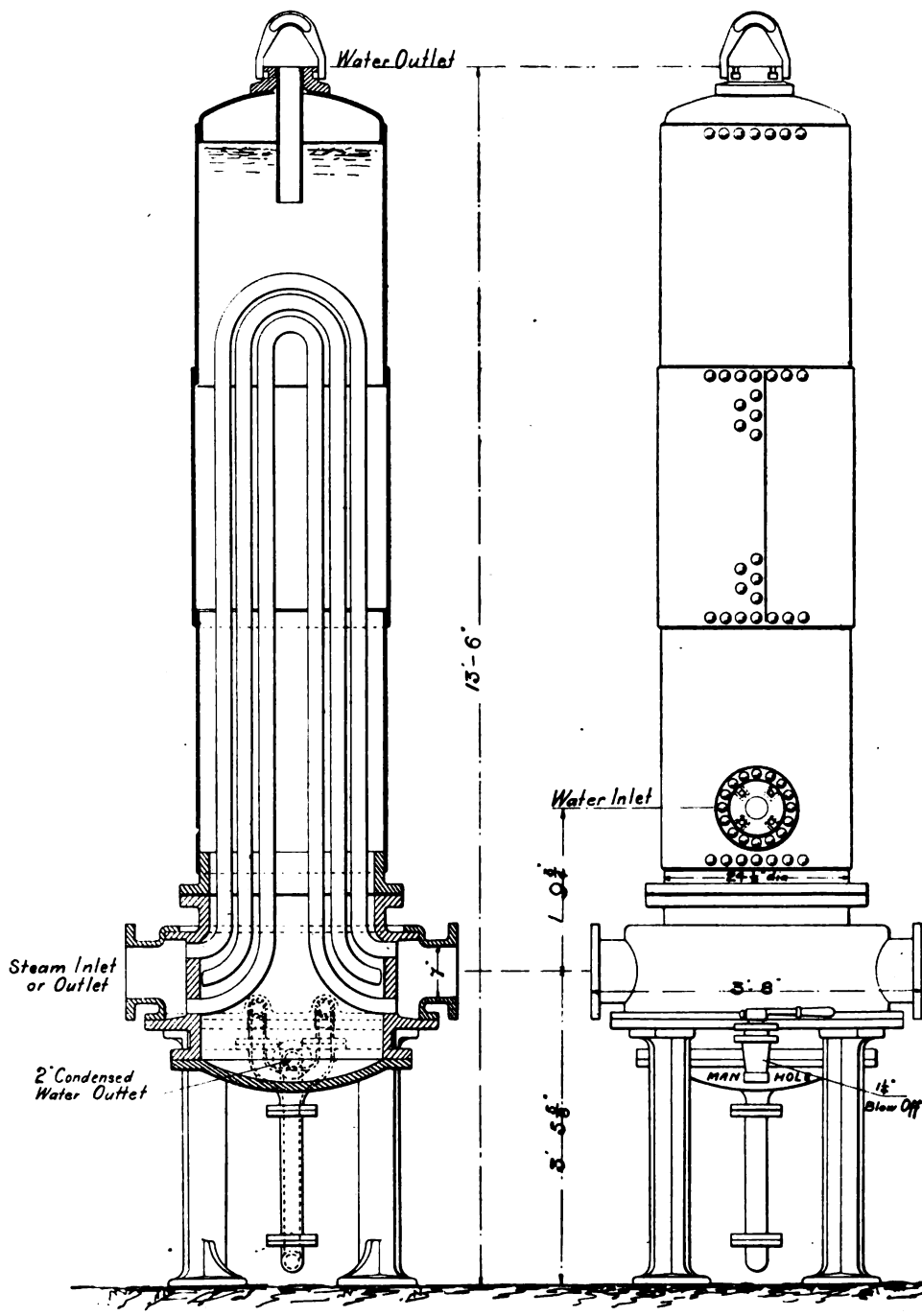

FIG. 4A.—Elevation and Section of the Brown-Berryman Heater

The two exciters are shunt wound, and each is capable of giving 60 amperes at 100 volts for exciting the large generators, or of working up to 135 volts for charging the accumulators in the station. These, too, have the Eickemeyer-wound armatures of the drum type and horizontal brushes. The lubrication of these machines is, however, effected by the ring method. A ring suspended on the shaft in the centre of the bearing drops into an oil-well in the pedestal, and as the shaft revolves carries the oil up to the bearing. These machines also supply the lights in the station, one of them being sufficiently powerful to excite all three of the large dynamos at the same time.

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A battery of accumulators is provided in a room at the side of the engine-room. It consists of 57 cells of the Electrical Power Storage Company's K 11 type. This is used for lighting the station and supplying the exciting circuits when the exciters are not running. It has a capacity of 125 ampere-hours when discharging at a rate of 25 amperes.

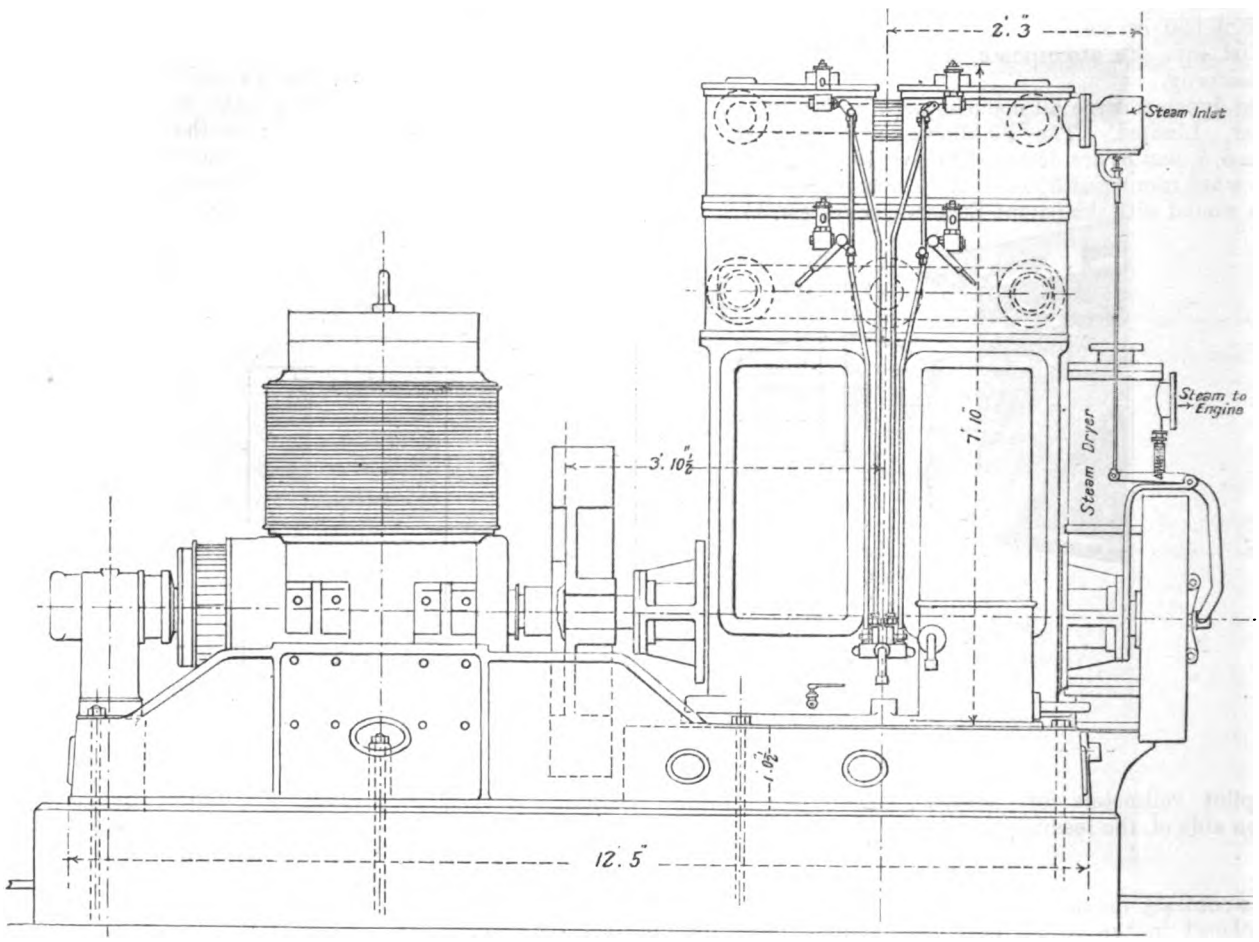

FIG. 6.—Elevation of the 80-K.W. Parker-Chandler Steam Dynamo.

Switchboard.

The switchboard (Fig. 9) consists of 10 panels of unpolished slate mounted on substantial wood backings, and, in addition, six low-tension voltmeters are mounted on a wood boarding above. Of these panels there are three generator panels, each fitted with an ammeter for measuring the currents generated by the three dynamos; one double-pole automatic magnetic cut-out and main switch (the automatic cut-out on the main switch is set to break circuit should the current rise to twice the normal full load—*i.e.*, 80 amperes); one 17-way field-regulating switch; one ammeter for field circuit; and one switch for opening the field-magnet circuit and short-circuiting the same on itself. This switch is of the throw-over type, so designed that the field winding is short-circuited directly the connection to the exciting E.M.F. is broken.

Two exciter panels, each fitted with one ammeter for showing the output of the exciters, two double-pole switches and fuses for connecting exciters to the 'bus bars or to the accumulators, and one nine-way shunt-regulating switch.

One battery panel, fitted with one ammeter for measuring the charging or discharging current, two double-pole switches and fuses for connecting the battery to either the dynamo charging bars or to the station lights and exciting circuit, and one six-way regulating switch for varying the number of cells in circuit.

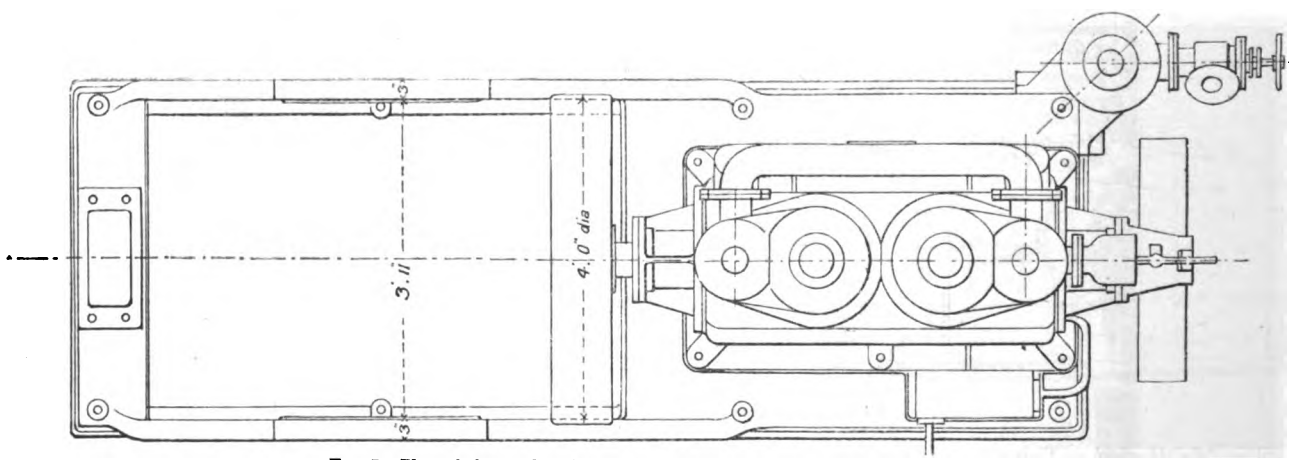

FIG. 7.—Plan of the 120-h.p. Bumsted-Chandler Engine and Extended Bedplate.

One voltmeter panel, containing two "Kelvin" voltmeters, each reading up to 2,100 volts, one being connected across the main 'bus bars and the other to a three-way double-pole plug switch for paralleling generators.

Three transformer feeder panels, each fitted with one ammeter, one double-pole automatic magnetic cut-out and main switch (the magnetic cut-out breaks the circuit in case a shunt occurs on the feeders); one 33-way transformer starting and regulating switch; single-pole switch

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for short-circuiting pilot wires. Resistances are provided for starting and regulating each of the transformers, and these are connected up to 33-way switches.

The voltmeters above the slate panels are used as follow: two for the exciters, one for the batteries, and three large-dial pilot voltmeters for indicating the E.M.F. at low-tension side of the feeding points.

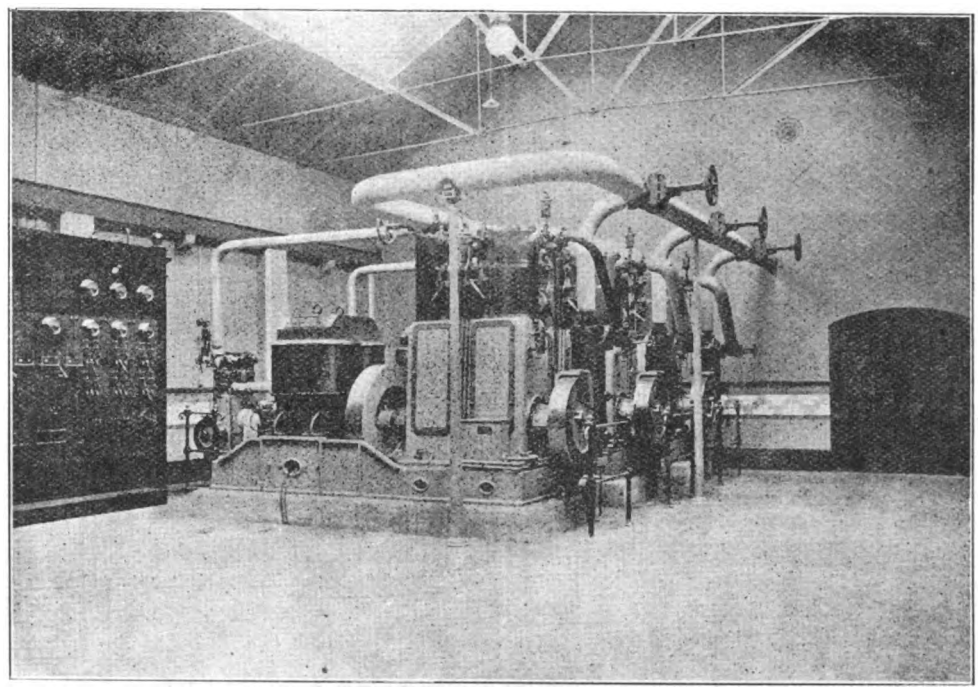

FIG. 5.—General View of Engine-Room.

Mains.

The contract for the whole of the underground mains was placed in the hands of Callender's Bitumen Telegraph and Waterproof Company, Limited, and the whole work has been carried out by them under the charge of their resident engineer, Mr. A. Burton. The Callender Company have not only supplied the cables and laid them, but have carried out all the street work, excavation, and permanent reinstatement. The supply is by continuous current, generated at a pressure of about 2,000 volts at the electric lighting station in the gasworks yard (Fig. 10), and distributed thence by concentric vulcanised indiarubber cables drawn into cast-iron pipes to three sub-stations, which are placed at convenient points in the town. These are shown by black circles in the plan, and are situated as follow: No. 1, in basement of a shop at junction of Stafford-street and Park-street; No. 2, in basement of St. George's Hall in Darwell-street; No. 3, in basement of Assembly Rooms in Goodall-street. The section of the feeder cables used is in each case $^{19}/_{16}$.

From the electric light station to the point where the mains branch off to the first sub-station—*i.e.*, at the corner of Stafford-street—the feeder-pipes are two in number, each having a diameter of 4in. From thence two 3in. pipes lead to the bridge, and from there one of the 3in. pipes is taken to each sub-station. The approximate distances from the generating station to the sub-stations are as follow: to No. 1, 700 yards; to No. 2, 1,090 yards; to No. 3, 1,285 yards; and the total length of feeding cable which has at present been drawn in is about 3,100 yards. In addition to these, a

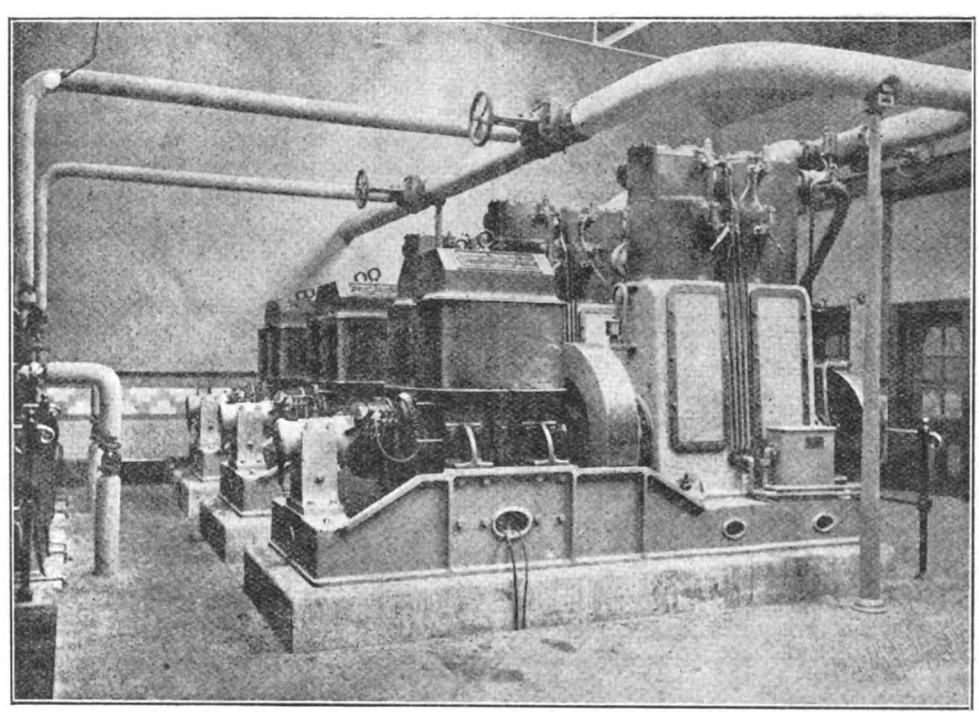

FIG. 8.—View from the Switchboard of the Three Large Steam Dynamos.

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separate 2in. cast-iron pipe is laid concurrently with the high-pressure concentric pipes, and contains for each sub-station two single-conductor pilot wires, each No. $^{7}/_{22}$, and a two-core telephone cable, each conductor being $^{3}/_{22}$.

(Fig. 10), have been constructed on the pipe lines with blue Staffordshire bricks set in cement 9in. work. They are provided with Callender's well-known type of double lid, each lid being set separately and distinct from the other,

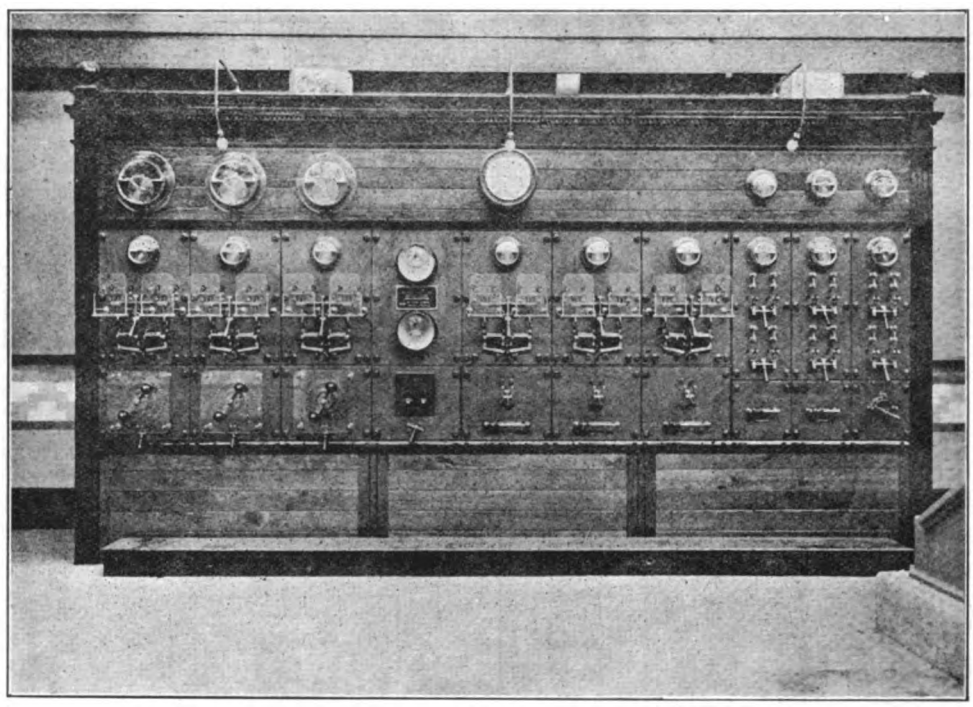

FIG. 9.—The Walsall Switchboard.

These go from the generating station to each of the sub-stations. About 7,200 yards of single-conductor pilot cable and about 2,500 yards of two-core telephone cable have been used. The cast-iron pipes are Post Office specifi-

so that in the event of any accident to the mains the outer lid will not become electrically charged. The inner lid is thoroughly earthed, being in metallic connection with the pipe lines. Each section of pipe line is also in metallic

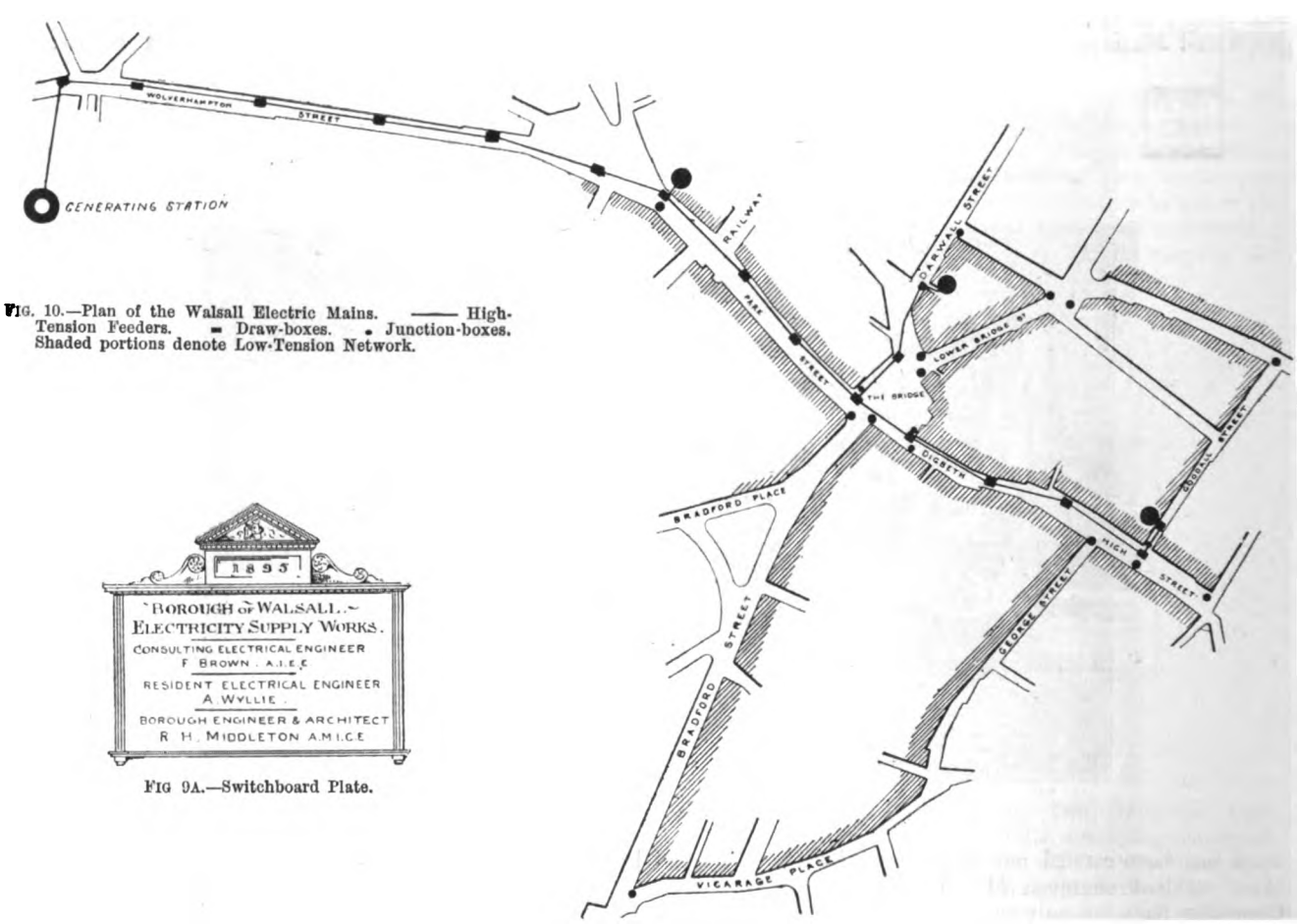

FIG. 10.—Plan of the Walsall Electric Mains. —— High-Tension Feeders. ▪ Draw-boxes. • Junction-boxes. Shaded portions denote Low-Tension Network.

FIG 9A.—Switchboard Plate.

cation, coated out and inside with Dr. Angus Smith's solution. Their joints are all carefully made with blue lead and yarn.

The draw-boxes, shown by black rectangles in the plan

connection with the next by means of strands of copper wire. There are 18 boxes on this pipe line, of which 11 are 24in. by 24in. on the heavy line, and seven are 20in. by 20in. on the single-pipe lines. The depth of the boxes

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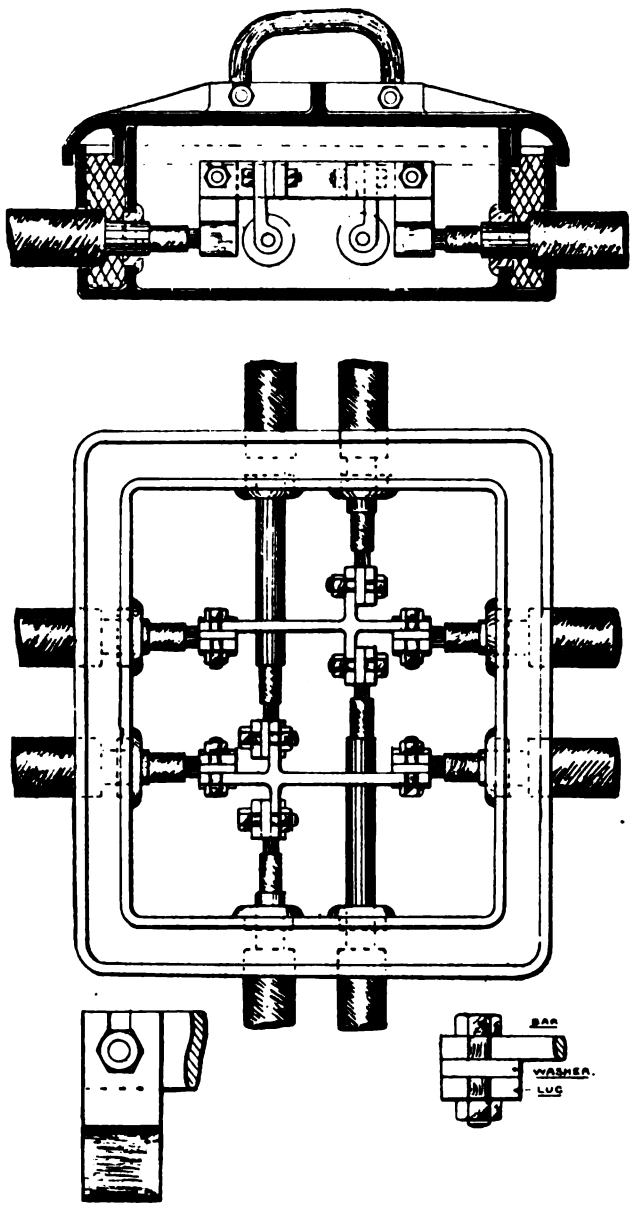

FIG. 11.—Callender's Network Box.

From each sub-station a network of low-pressure cable is carried through the principal streets of the town, and distribution is made on the two-wire system. The network consists of single-conductor, lead-sheathed, and steel-armoured cables of Callender's well-known type laid two side by side. The section of these mains is ·54 square inch in the busy streets and ·25 in those of lesser importance. About 1,600 yards of ·54 main have been laid and 2,500 yards of ·25, so that double that amount of cable has been used.

The streets in which the network is at present laid are as follow: Park-street, Digbeth-street, St. Paul's-street, Bridge-street, Leicester-street, Vicarage-place, The Bridge, High-street, Darwell-street, Goodall-street, George-street, Bradford-street.

Network boxes (Fig. 11) of Messrs. Callender's standard type, have been placed at the corners of all the important streets where the distributors are placed, and at present there are 17 of them. Fig. 12 shows the process of fixing on of these and the facility with which they are connected to the cables. Each of these boxes is placed in a pit built of blue bricks set in cement, and provided with cast-iron frame and concrete-faced surface cover. Consumers are connected with the mains by means of cast-iron service boxes, buried in the ground without any pit or other protection in the same way as gas services

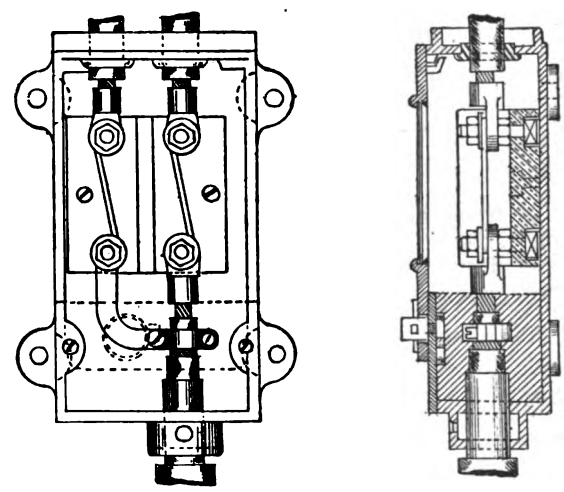

FIG. 13.—Reid's House Connection and Fuse Box.

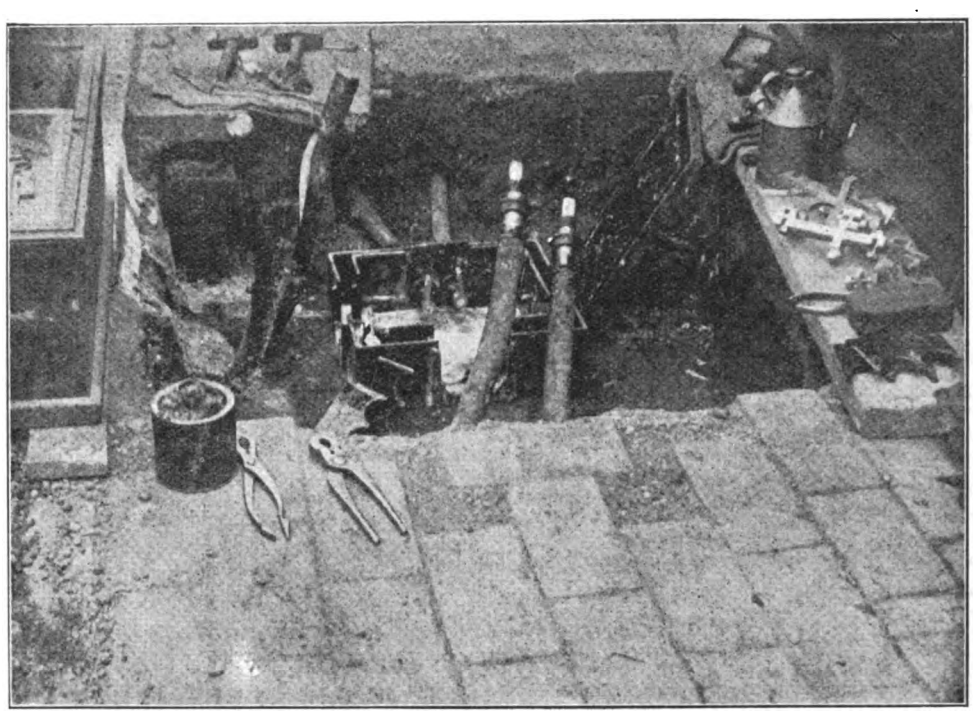

FIG. 12.—View of a Junction Box in Course of Fixing.

varies, as the pipes have been laid to give a fall into each box, and it has therefore been necessary to excavate somewhat deeper than was expected. Some of the boxes, in consequence, are fully 7ft. deep.

are connected. There are at present over 40 consumers thus joined up, and more are probably being added.

(Continued on page 711.)

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THE INSTITUTION.

According to the report of the meeting last week, some of the members were on the warpath. It is somewhat difficult to know the cause of the storm, or to find out the goal of those adverse to the Council. The first thing to remember is that for this year the Council has been elected, and however much individual members may object to men on that Council, bygones must be bygones. If objection is to be made, it must be directed towards next year's house list. We admire the plucky way in which the hostility to the Council was shown, although we do not think the hostility was correctly directed. There seems to be a series of distinctions, too fine drawn to impress us with their value. Thus, men are suitable as ordinary members, but not as members of Council; they are all right as members of Council, but not as vice-presidents; they are all right as vice-presidents, but not as president. Now, we are not going to summarise the leading points put forward by the contestants—there is plenty of time for that—but we do want a categorical statement from the objectors of their objections. The Institution is an incorporated society, governed by legal articles. Have these articles been carefully read? Do the members know the rules and regulations under which they are governed? If not, we would suggest as the first act of the new Council that it issues a number of the *Journal* giving these details. The ordinary members will then see what their rights are under the articles and what their wrongs. They will see how far, under these articles, they are powerful to elect the members of the Council. It is useless asking for this and for that if the request be contrary to the articles, but it is very tantalising when members get up to air just complaints to find by these unknown articles they are out of court. It may be well at once to say that in our estimation a committee such as that hastily proposed at the last meeting is unworkable and unwarranted by the condition of the Institution. Destructive criticism is easy enough. Anybody can become an iconoclast. That is not what is wanted, but rather constructive criticism to tell us what to do when a vacant space is created by knocking down some existing institution. An idea seems to underlie recent criticisms that the Council is elected to formulate courses of action, bring the formulæ to the notice of the members, or some of them, and, if sanctioned, to proceed in the action. If that idea exists, the sooner it is got rid of the better. The Council is a body of men elected by the members to carry on the ordinary work of the Institution without worrying members over every petty detail of daily routine. It is supposed to consist of capable representative men who have the welfare of the Institution at heart, and who will be always ready to sink the interests of self in the interests of the Institution. Every section of the members is by the ideal Council to have a representative, but we know how difficult it is to find the ideal in the real. However, discussion on these and other points may be left for a few weeks; let us first know where we stand, and this can only be done by knowing the articles under which we are governed. Will the Council consider the suggestion

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and issue the articles before the general meeting promised last week to discuss the differences between Council and members is called?

FIRES AND ELECTRIC LIGHTING.

We are glad that Major Flood Page has again called attention to this subject through the columns of the *Times*. It is a subject of the utmost interest, and should therefore be approached without prejudice. We fear Major Flood Page has made out too favourable a case for electric lighting. His statistics are really statistics of facts, but the facts are not of the kind to allow of too broad a generalisation. In the first place, the number of electrical installations, gas, and oil burners in competition are unknown. If we could have the number of electric lamps, the number of gas burners, the number of oil lamps, and the number of candles in use, we might then get the percentage of fires arising from each source, but to say there was only one fire from electricity and one hundred and seventy-five from candles in 1892 is somewhat misleading as regards correct conclusions. It may be that the percentage of fires arising from candles is less than the percentage arising from electricity. We do not for a moment believe that it is so, but we cannot from the figures given by Major Flood Page prove that it is not so. It is to be regretted that Major Flood Page has thought fit to resuscitate controversy on the pressure question. Every electrical engineer, every municipality, everyone, in fact, interested in the question, had full liberty to put his views forward at the recent conference, and surely, after that conference, we might have been held safe from further criticism. What was the use of the conference if the thing is to be discussed in the newspapers? The householders will naturally take hold of these differences of opinion and ask, who is right? You cannot explain to the ordinary householder that so far as the old wiring is concerned the section is more than ample to carry the lesser current without heating; in fact, that so far as the conductor is concerned, the danger is lessened by the increased voltage, and that any increase of danger will arise from defective insulation and arcing. It may be that the existing fuses will be sufficiently sensitive under the new conditions, but if doubt arises they can be changed with little trouble or expense. All the new wiring will bear the same relation to the new conditions as the old does to the old conditions. All these details, however, are questions for experts, not for the general public; and as the experts in solemn conclave have advocated the change, we must again say that Major Flood Page's remarks are a little out of place in being put before non-technical readers.

Magnetic Surgery.—The extraction of steel particles from the eye is a subject which has especial interest for Sheffielders. It seems that since Mr. Snell's appointment to take charge of the eye department in 1877 no magnets or electromagnets have been used at the Sheffield General Infirmary except those devised by him. Since then Mr. Snell's numerous papers on the removal of small steel fragments from the eye, and his volume on the subject, have secured for the instrument literally a world-wide repute.

WALSALL ELECTRICITY WORKS.

(Concluded from page 709.)

These network boxes are shown by small black circles on the plan (Fig. 10), and the side of the streets now served by low-tension cables are shaded. The service cable used is single-conductor lead-sheathed and armoured similar to the mains used in the streets, except that it has a smaller section. This runs from the mains direct into the consumers' premises, where it terminates in one of Reid's patent cut-out boxes (Fig. 13). This box acts not only as a cut-out, but as a permanent seal for the cable end, preventing any injury to the cable even in damp cellars.

Great care was taken in the laying and jointing of these cables, as may be gathered from the fact that the whole network tested over 400 megohms when completed, although the specified limit was 50 megohms. At the same test, no deflection was found when testing all these feeders in parallel, hence showing infinite resistance.

Sub-Station Outfit.

There are three sub-stations, the principal one being at the St. George's Hall, where the battery is fixed. In each of these there is at present one motor-generator. These transform down the high tension supplied by the feeders, and have an output at the secondary terminals of 105 volts, 400 amperes, when supplied with primary current at 1,950 volts. They run at a speed of about 550 revolutions per minute, but the transforming ratio is independent of the speed. Fig. 14 shows two views of these machines, which have the Parker patent hinged poles to allow the armature to be removed by lifting directly upwards. The field magnets, which are of cast steel, have two windings, the one being in series with the primary high-tension armature, and the other as a "shunt" across the low-tension armature. The series winding is only used in starting, and is designed to reduce the starting current to a value at least half of that required by the similar continuous-current transformers at Oxford. It is short-circuited as soon as the voltage on the secondary or low-tension armature rises above 80 volts. The removal of the resistance of the series-turns is also a great advantage, as it gives a much more constant regulation at varying loads. The bearings are fitted with automatic lubricating pumps, in addition to rings, which also give continuous lubrication. The pumps, which are worked by eccentrics on the shafts, are connected on the delivery side to the under part of the bearings.

The other parts of each sub-station outfit consist of one long-range switch for closing the secondary circuit from the transformer to the network. It is operated from the central station, the magnet coils being wound with wire in series with the pilot wires. Combined with this switch there is an automatic magnetic cut-out, which breaks the circuit in the event of too great current being demanded, or in event of the current coming back from the network, due to the transformer for any reason failing to give its proper E.M.F. The details of this switch are shown in Fig. 15. E is the cup-shaped electromagnet, the armature being in the attracted position. R is the rachet wheel, which on alternate strokes puts the low-tension switch, S, on and off; it is moved by the pawl, P, on the armature frame. M is the magnetic cut-off, which releases the switchbar, C, should the current rise abnormally.

One series field short-circuiting switch is also supplied with each main transformer. It consists simply of a horseshoe magnet wound with wire in series with the shunt circuit of the transformer. When the current rises to a point equivalent to 80 volts, the armature is attracted, and the switch short-circuits the series winding on the transformer magnets.

Besides these two switches there is additional plant connected with the accumulators at the main sub-station at St. George's Hall. This main battery consists of 114 cells in lead boxes, manufactured by the Electrical Power Storage Company, each containing 50 K, or high-discharge plates. These cells are capable of discharging at 150 amperes for five hours, or, in cases of emergency, this rate can be easily doubled for short periods. The cells are contained in lead boxes (Fig. 16), and each consist of two

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parallel sections of 25 plates. They are connected in two sets of 57 cells each, and then connected in parallel, if desired, at the switchboard.

regulated by means of a resistance in the primary circuit. The battery switchboard is a slate panel fitted with two ammeters, one for each battery; two voltmeters; two

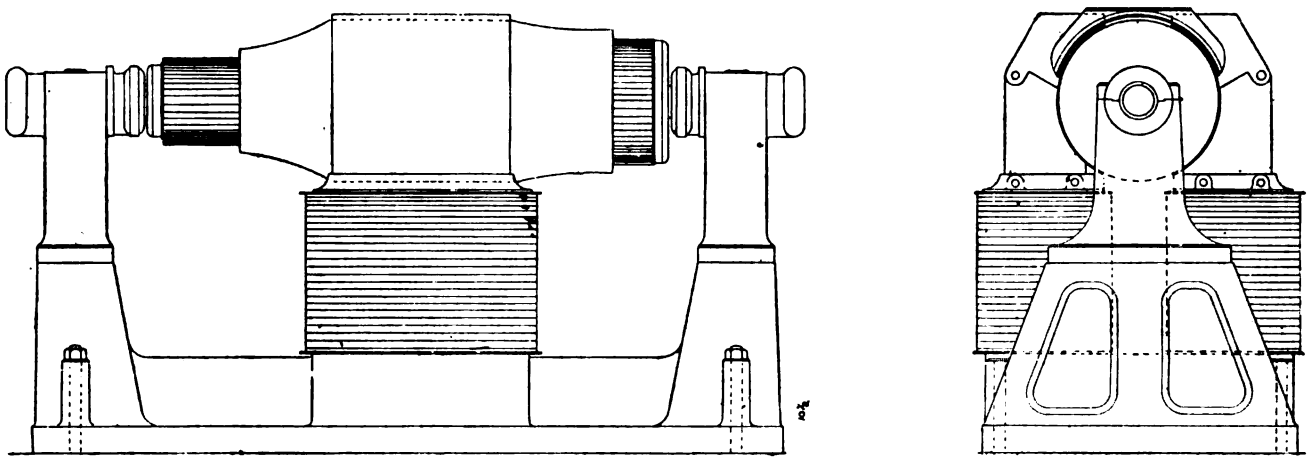

FIG. 14.—Motor Generator Transforming from 2,000 Volts to 105 Volts.

A battery-charging transformer, or booster, is also fixed at the central sub-station. It takes its primary current at 105 volts from the distributing network, giving an output

throw-over switches for putting batteries to charge or discharge; two switches for taking the batteries out of circuit or for switching them on; two double-pole fuses;

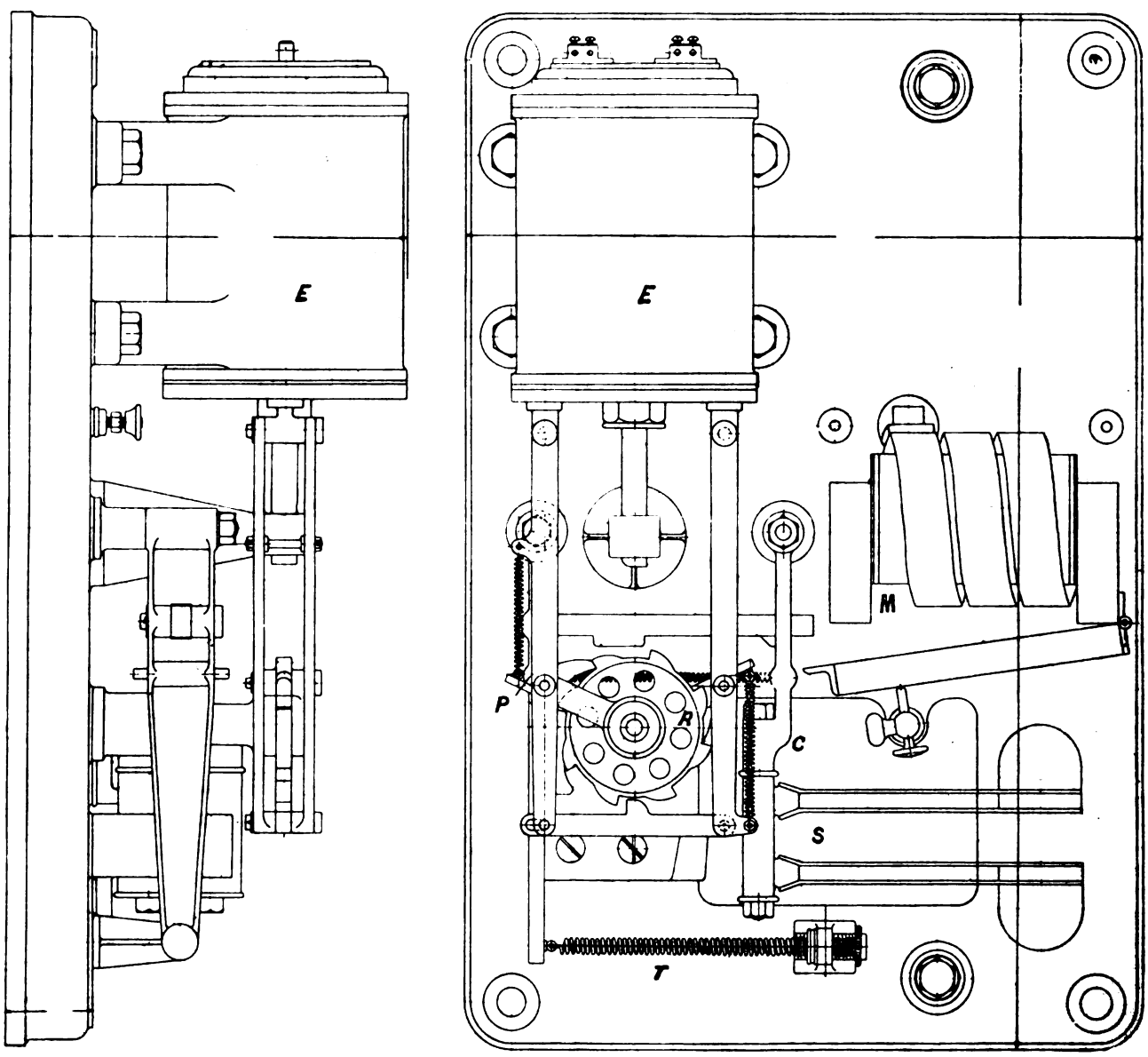

FIG. 15.—Plan and Elevation of Parker's Magnetic Long Range Switch.

at the secondary of 300 amperes at 35 volts; this being connected in series with the distributing network, makes a total of 140 volts for charging. The E.M.F. is

two six-way battery-regulating switches, to vary the cells in use; and one transformer starting and regulating switch.

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Method of Working.

The generators are excited in the usual manner from the exciters or battery, and are run in parallel, feeding on the main omnibus bars. From this the feeder circuits take their supply through the double-pole cut-outs, and feed the transformer sub-stations. The battery is always on the network when the transformers are not running, and they maintain the proper E.M.F. on the mains at light loads. To start the transformer, the main feeder switch at central station is put on, the starting switch being turned so that all the resistance is in series with the high-tension armature and the series winding on the magnets of transformer at the distant sub-station.

The resistances are so adjusted that with 2,000 volts on the 'bus bars about seven amperes will pass through the circuit. This starts the transformer, and as it gains in speed the shunt circuit of the transformer connected across the secondary armature becomes energised. The current passes round the magnet of the series field short-circuiting switch, and energises this. It then draws the armature up, and short-circuits the series coils, leaving the shunt only to energise the transformer magnets. When this has occurred, it can be seen by the man in charge of the switchboard at the central station, as by watching the ammeter he sees the current going down as the transformer gets up speed. The 33-way switch is then turned round so as take out the starting resistance. The single-pole switch at the central station is then closed, thus short-circuiting the voltmeter on the pilot wires. This causes sufficient current to pass round the magnet of the long-range switch for it to attracts its armature, and so close the circuit from the secondary of the transformer to the distributing network. The regulation of the E.M.F. of the system is controlled from the central station by increasing the E.M.F. of the generators as the load comes on to allow for the drop in feeders and transformers.

Extra means for regulation of any differences there may be between the various transformers is carried out by inserting a resistance in the feeder circuits, this being put in or out as required by means of 33-way switches. To take transformer off circuit the reverse process is carried out, the secondary circuit being first opened by short-circuiting the pilot wires, and so operating the long-range switch. In event of one of the cut-outs on the secondary of the transformers opening the circuit, the long-range switch is left in a position that it can again be closed from the central station exactly in the same manner as when putting on circuit in the usual way.

The whole system is carried out under the patents of Parker, Woodward, and Rees.

The prospects of the undertaking are exceedingly good, as the equivalent of over 3,500 8-c.p. lamps are now connected and being regularly supplied. The orders actually in hand show that a load of over 5,000 may be expected before the end of the winter. The station engineer is Mr. Alex. Wyllie, who, after experience of the similar system at Oxford, joined the staff, and has assisted Mr. Brown in the supervision of the work in course of construction. The charges authorised by the Council for electric energy is 6d. per Board of Trade unit for lighting purposes, and 4d. per unit for motors. The motor load is expected to be a valuable item in the revenue, as five motors are already at work. The energetic chairman of the Electric Lighting Committee (Mr. T. Brownhill) has throughout shown great personal interest in the undertaking, and has received every support from the Mayor (Mr. Joseph Noake, J.P.)

FIG. 16.—View of the Main Batteries in the Chief Sub-Station.

The following is the approximate cost of the various parts of the present plant:

Buildings	£2,058
Engines	1,582
Dynamos, switchboards, transformers, and accumulators	5,600
Boilers	834
Mains	4,845
Pumps, feed, heater, steam and exhaust pipes, etc.	875
	£15,794

The total amount allowed to be borrowed by the Local Government Board was £22,000, so that the funds have not been exhausted.

THE INSTITUTION DINNER.

The annual dinner of the Institution of Electrical Engineers was held on Friday, the 13th inst., at the Freemasons' Tavern, Great Queen-street. Mr. R. E. Crompton, the President, was in the chair, and about 250 of the members and their friends were present. The guest of the evening was H.R.H. the Duke of Cambridge, K.G., K.T., K.P., and the guests included, amongst others, Lord Claud Hamilton (chairman of the Great Eastern Railway Company), Mr. J. Wolfe Barry (vice-president of the Institution of Civil Engineers), Sir J. Crichton-Browne, F.R.S. (treasurer,

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Royal Institution), Colonel A. C. FitzGeorge (equerry-in-waiting to H.R.H. the Duke of Cambridge), Sir Thomas Blomefield, Bart. (Board of Trade), Dr. A. G. Vernon Harcourt, F.R.S. (president, Chemical Society), Mr. H. Edmunds (president, Northern Society of Electrical Engineers), General Markham, R.A. (Director-General of Artillery), Mr. C. G. Mott (chairman, City and South London Electric Railway), Colonel Sir John Ardagh, K.C.I.E. (commandant, S.M.E., Chatham), Colonel W. de W. Abney, R.E., C.B., F.R.S. (president, Physical Society), Mr. John Bell (chairman, Metropolitan Railway). The following gentlemen were also present:

Sir F. Abel, Mr. H. G. Allen, Mr. R. W. Allen, Mr. W. H. Allen, Mr. Amy, Mr. Anning, Mr. Anson, Mr. E. Ashton, Mr. Ashton, Mr. Aubert, Prof. Ayrton, Major Bagnold, Mr. F. Bailey, Mr. Barley, Mr. Bathurst, Mr. Beadle, Mr. Beaumont, Mr. Belshaw, Mr. Benedict, Mr. H. Bennett, Mr. A. Bergtheil, Mr. Bevis, Mr. Billington, Colonel Bingham, Mr. G. Binswanger, Mr. M. Binswanger, Mr. Birt, Mr. Black, Mr. Boot, Mr. Brett, Mr. Briault, Mr. E. J. Bristow, Mr. G. L. Bristow, Mr. Brockman, Sir W. R. Brooke, Major Cardew, Mr. E. Cardin, Mr. J. Cardin, Mr. Carpmael, Mr. W. A. Chamen, Mr. C. T. D. Chamen, Mr. Von Chauvin, Mr. Cheesman, Mr. W. Clark, Mr. Latimer Clark, Mr. Cluer, Mr. Coles, Mr. Colvin, Mr. Comport, Mr. Cooke, Captain Creak, Mr. Cree, Mr. R. S. Crompton, Mr. Crookes, Mr. Crowe, Mr. Curra, Mr. Dale, Mr. D'Alton, Mr. W. H. Davies, Mr. E. F. Davies, Mr. Dearlove, Mr. Devonshire, Mr. Doherty, Mr. Donnie, Mr. Down, Mr. Dowsing, Mr. J. E. Dowson, Mr. W. Dowson, Mr. Drake, Mr. Drysdale, Mr. Duddell, Mr. Eden, Alderman Ellis, Viscount Emlyn, Mr. Epstein, Mr. Erskine, Mr. Esmond, Mr. Esson, Mr. Evans, Mr. Fairfax, Mr. Ferranti, Mr. Ffinch, Mr. Fisher, Mr. Fleetwood, Prof. Forbes, Mr. Ford, Mr. H. B. Forde, Mr. Francis, Mr. Gabbett, Mr. de Calindez, Mr. Garcke, Mr. Gavey, Mr. G. Gibson, Mr. J. Gibson, Mr. A. Gordon-Smith, Mr. J. Gordon-Smith, Mr. Gorham, Mr. Gray, Captain Griffin, Mr. Grindle, Mr. Gye, Mr. Hall, Mr. R. Hammond, Mr. Handcock, Mr. Harris, Mr. H. T. Harrison, Mr. H. E. Harrison, Mr. Hatt, Mr. Hawkins, Mr. Heaviside, Mr. Hill, Mr. Hirst, Major Holden, Rev. Dr. Holden, Mr. Hookey, Mr. Hope-Jones, Mr. G. Hopkins, Dr. Hopkinson, Prof. Hughes, Mr. Hughes, Mr. Jacob, Mr. Jeffery, Mr. Jenkin, Mr. C. F. Kemp, Mr. Kempster, Mr. King, Mr. Kolle, Mr. J. C. Lamb, Mr. J. F. Lamb, Mr. Larkin, Prof. Larmor, Mr. Lassall, Mr. de Lattre, Mr. H. F. Lewis, Mr. Slater Arnold, Mr. Lloyd, Mr. Low, Mr. McMahon, Mr. McMullen, Mr. Madgen, Sir H. Mance, Mr. Manville, Mr. Marsh, Mr. Mavor, Mr. Medcalf, Mr. Miller, Prof. Milne, Lieutenant Montgomery, Mr. Mordey, Mr. Morse, Mr. B. Mott, Mr. Nalder, Mr. Offor, Mr. O'Shaughnessy, Mr. Paget-Waddington, Mr. Parshall, Mr. Parsone, Mr. Partridge, Mr. Paul, Mr. Pearce, Mr. Pell, Mr. J. D. Pender, Sir J. Pender, Mr. Penton, Prof. Perry, Mr. Petersen, Mr. Peto, Mr. Phillips, Mr. Pomeroy, Mr. A. H. Preece, Mr. W. H. Preece, Mr. W. L. Preece, Mr. N. Prentice, Mr. M. Prentice, Mr. Pritchett, Mr. Rausch, Mr. J. J. Rawlings, Mr. W. R. Rawlings, Mr. T. Rawlins, Mr. W. Rawlins, Mr. Raworth, Mr. Reavell, Mr. E. H. Reeves, Mr. F. Reeves, Mr. Reid, Mr. Reynolds, Mr. Roberts, Mr. Robinson, Mr. Rosenthal, Mr. Samuelson, Mr. Seymour, Mr. Shackleford, Sir E. M. Shaw, Mr. Sherrin, Mr. Short, Mr. Dane Sinclair, Mr. F. Smith, Mr. H. W. Smith, Mr. R. A. Smith, Mr. Snell, Mr. Spagnoletti, Mr. C. P. Sparks, Mr. E. L. Sparks, Mr. H. C. Sparks, Mr. Spilsburg, Mr. Stearn, Mr. Stevens, Mr. Stewart, Captain Stiffe, Mr. Still, Mr. Stothert, Mr. Stottner, Mr. Stroh, Captain Stuart, Mr. Stuart, Mr. C. Swan, Mr. J. W. Swan, Mr. Swinburne, Mr. Swinton, Mr. Taylor, Prof. S. P. Thompson, Mr. Tree, Mr. Trezise, Mr. Trotter, Mr. Tufnell, Mr. de Tunzelmann, Mr. Verity, Mr. Vose, Mr. Voysey, Mr. Walby, Mr. Wallace, Mr. Wallis-Jones, Mr. A. F. Ward, Mr. J. Ward, Mr. F. Ward, Mr. Warden-Stevens, Mr. Webb, Mr. R. W. Weekes, Mr. Wilkinson, Mr. J. Wilson, Colonel Wood, Mr. Wood, Mr. A. Wright, Hon. F. G. Wynn, Mr. Young.

The PRESIDENT, after dinner, proposed the usual loyal toast, and referred to the honour of having a member of the Royal family present. He said that the Prince and Princess of Wales had from the commencement showed a great personal interest in electrical development.

Mr. W. H. PREECE, C.B., F.R.S., proposed the toast of "The Learned and Engineering Societies," and in the course of his speech observed that the weapons which scientific and practical men now used were observation and experiment, but the great distinguishing feature that the electricians had introduced into the world had been absolute and accurate measurements. It was by accurate measurement that the last and greatest discovery was produced, principally within the walls of the Royal Institution, where Lord Rayleigh had been able to detect in the atmosphere that which had eluded the observations of thousands of years—the mysterious argon. Science and engineering combined had led to happiness and to rest, and thus it was that the members of the learned societies and of the engineering world were ministers of peace. He coupled with the toast the names of Sir James Crichton Browne, F.R.S. (hon. treasurer of the Royal Institution), and Mr. John Wolfe Barry, C.B. (representing the Institution of Civil Engineers).

Sir J. CRICHTON BROWNE,* in responding, said that the learned societies of all sorts and sizes and denominations regarded the electrical engineers with intense interest and curiosity, with a lively sense of what they had already done for human advancement, and with keen expectancy as to what they were going to do next. The Royal Society, the chief parent of all the learned societies, was of course charged with electricity in every pore, and was indeed one huge transformer. He assured them that the learned societies devoted to the consideration of mental and nervous diseases were compelled to watch them very closely, for it was unquestionable that they were increasing the bulk of the wear-and-tear diseases with which those societies had to deal. There could be no doubt that by their discoveries and their applications electrical engineers had made life more intense and hurried than it formerly was. They had augmented the strain and stress of existence, and so had contributed to the multiplication of wear-and-tear diseases—of those heart diseases, degenerative diseases, nervous diseases that now abounded so copiously around us—and there could be no doubt that they had by the very magic and mystery of their achievements given a definite colour to the wanderings of many disordered minds. He had no hesitation in affirming that the tripod upon which delusional insanity now rests was made up of theology, hypnotism, and electricity, representing respectively the spiritual, the biological, and the physical aspect of man's nature, and not a day passed that he had not in his official capacity to listen to strange tales as to the iniquities of the telephone and the illicit employment of the electric light. But if electricity had swollen the tide of nervous diseases and tipped some of its breakers with foam, it had also brought compensations, for it had given them new and valuable means of treating disease, especially diseases of the spinal cord, and it had given increased facilities for securing the advice of eminent London physicians in cases of nervous disease in any part of the country—facilities of which, he regretted to say, the public still only too sparingly availed themselves.

Mr. J. WOLFE BARRY, replying for the engineering societies, said the future of electric engineering was immeasurable. Civil engineers, whether their business was to deal with the construction of bridges, railways, or docks, were under the deepest obligation to the electrical engineers. They found the use of electricity was more and more necessary and useful in every walk of the profession.

Sir FREDERICK ABEL proposed the toast of "Our Guests," and referred to the pleasure it gave him, as one of the oldest past-presidents, to see such a large and influential gathering. He was glad to see the chairmen of various railway companies present as a mark of the great assistance electrical engineering was to them. Above all, he welcomed the Duke of Cambridge as an illustrious representative of the British Army. In whatever direction progress had been made in the equipment of the army, the Duke had always taken an active lead, and had always been ready to consider carefully proposed improvements in the scientific outfit of both the Royal Engineers and the Royal Artillery.

The DUKE OF CAMBRIDGE, in reply, said that from the position he had had the honour to occupy for such a number of years, he had had the opportunity of judging of the advantages of science in relation to the army. He did not suppose that any profession had gained more by the scientific progress of recent years than the army, and, he might say, the navy. They had now these great services in a condition which certainly when he commenced his career no human being would have thought it possible to

* We are indebted to the *Times* for these verbatim speeches.

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attain in the period of a man's life. For his own part, he had never thrown any obstacle in the way of valuable and useful improvements which time and science had brought about. Though he had now retired from the army, his reward was that he had gone from it with the affectionate feeling of the army, and, he believed, with the kind and generous feeling of the public at large.

The DUKE OF CAMBRIDGE afterwards proposed "The Institution of Electrical Engineers," and coupled with the toast the name of the President—his old subordinate.

Mr. R. E. CROMPTON, in reply, referred to the tremendous advances made by the electrical industries. He considered that we were on the verge of an electrical age, if not actually in it. The profession was attracting to it the pick of the rising generation. The effects of the advance were difficult to foresee, but the great facilities given by electricity for transport purposes and transmission of power might repopulate country districts. Even if the industries were not more scattered in consequence, electric traction would allow those engaged in the towns to live in the fresh air of the country.

FIRES AND ELECTRIC LIGHTING.

Major S. Flood Page writes to the *Times*, under this head, as follows:

"A considerable time has elapsed since you were good enough to afford me space to demonstrate in your columns that electric lighting properly carried out was the safest of all artificial illuminants. The fact that there have been fires in two central stations and in one electric works in the United Kingdom recently has, to use the words of an insurance writer, created an 'unfavourable impression in the minds of fire managers in regard to this class of risk.' As this impression may be reflected in the minds of some of those who have electric light in their houses, I trust that you will once more have the courtesy to grant me space to say a few words dealing with this important question.

"It will be within your recollection that I based the facts in my previous communication on the annual reports of Captain (Sir Eyre Massey) Shaw. His successor, Captain Simonds, has been kind enough to furnish me with his reports for the years 1892, 1893, 1894, which show that, within the metropolitan area, fires have taken place, caused by candles, gas, lamps, and electricity, as follows:

	1892.	1893.	1894.
Candles	175	235	157
Gas	265	284	284
Lamps	373	456	476
Electricity	1	5	3

So that there have been in three years, from the above causes, 814, 980, and 920 fires, of which only one, five, and three have been connected with electricity, or, taking the total of the three years, there have been 2 714 fires from the above causes, nine of which only have been in places lighted electrically. These facts will surely allay any feeling of anxiety in the minds of users of electric light as to there being any practical danger from electric light properly installed in their houses. They will serve to enforce the argument that by far the safest artificial light ever introduced into common use is the electric light.

"It is, of course, necessary to lay stress upon excellence of work. There is no more shortsighted policy for those who can afford the luxury of electric light than to allow cheapness to weigh, as against quality, when they are having their houses wired and switched ready for the electric light.

"I know nothing whatever about the internal working of the Phœnix Fire Insurance Office. I do not know whether the officials are more careful as to the fire risks they take than other offices, but the experience which we had before has been confirmed, in the past few years, that installations carried out under the stringent and valuable rules of the Phœnix Fire Office are safe and reliable, and I have ascertained within the last few days that the successful record of that company, with regard to electric light, still holds good. Though they were the pioneer company in electric lighting—the first who drafted any rules for our guidance—yet from the commencement up to the present day the Phœnix Fire Office has not had one single sovereign to pay as loss in connection with any fire in any building lighted electrically the installation and wiring of which has been carried out under its rules. Only nine fires for three years, within this vast metropolitan area, is in the highest degree satisfactory.

"I must, however, confess that I view with some alarm the efforts of some electrical engineers who are advocating an increase in, and in some instances actually increasing, the pressure at which they deliver the current of electricity to 220 volts, while the ordinary current has been 100 to 110 volts. It is supposed by some that a difficulty has arisen in the manufacture of incandescent lamps to meet this demand. Permit me to say that the lamp presents the smallest difficulty in connection therewith. A far more serious question, and one which touches very closely upon fire insurance, is whether houses wired with fittings and switches manufactured for 100 volts can safely carry 220 volts. It stands to reason that before this change can be made every house must be inspected, switches, wiring, and fittings thoroughly tested and examined. I have no hesitation in expressing my own opinion that it is far better that we should, for many a day yet, at any rate, be content with the useful safe pressure under which we have obtained the most satisfactory reports which these figures of the Metropolitan Fire Brigade show in connection with fire risks and electric light. I have said, and I repeat, that the lamp is probably the least difficult part of the whole question; but the question itself merits the most serious and earnest attention alike of those who supply and those who are using electric light for domestic purposes.

"Incidentally, I should like to remark that it is very doubtful whether the engineers who are advocating this increased pressure are entitled to do so, for the Electric Lighting Act, under which they are all working, provides that the undertaker shall not exercise any influence whatever as to the lamp which the customer is to use. The words of the Act are as follows: 'Electric Lighting Act, 1882.—The undertakers shall not be entitled to prescribe any special form of lamp or burner to be used by any company or person, or in any way control or interfere with the manner in which electricity supplied by them, under this Act and any license or special Act, is used.'

"The primary sense of these words is probably that the undertakers shall not recommend the lamp of any particular maker; but I think it cannot be denied that they also fairly bear the interpretation that the undertakers may not arbitrarily compel customers to change their lamps, which they must necessarily do if the current is supplied to them at 220 instead of 100 volts In all seriousness, apart altogether from any legal question, this increase of voltage must exercise so important an influence upon that of safety that I trust the most careful consideration will be given by all users of electricity before they will submit to such increase, no matter what inducement may be held out by those who advise them to make the change. If customers in one street are compelled to use lamps of 220 volts, and in another street of 100 volts, it can hardly be denied that the undertaker does prescribe the lamp which is to be used. Even if this increased voltage is intended to be applied to extensions rather than to existing installations, I consider that it is most unwise to raise the question at the very moment when the insurance offices are somewhat uneasy as to the risk involved in central stations and electric works. Rather let us do all that in us lies by excellent workmanship and safe pressure to maintain the satisfactory record of one fire from electricity to every 334 from candles, gas, and lamps within the metropolitan area.

"P.S.—Purchasers of electric fittings should be on their guard; a prosecution is now in progress, a number of men being charged with stamping inferior electric fittings made in Germany with the name of well-known English manufacturers."

INSTITUTION OF ELECTRICAL ENGINEERS, Dec. 12.

The Secretary read the following report of the Council:

Inclusive of the candidates to be balloted for this evening, the total number of additions to the register during the year will have been 216, comprising 12 foreign member, 9 members, 108 associates, and 87 students; and 38 candidates have been approved for election next month; one foreign member and 14 associates have been transferred to the class of members, and 71 students to the class of associates.

The losses which the Institution has sustained by death, although larger than those of last year, are fortunately, below the average; they are as follow: three foreign members, six members, and six associates. Of these we may mention Mr. Aparicio, who was originally in the Spanish Government Telegraph Service, and subsequently the representative of the Direct Spanish Telegraph Company, had been a foreign member for 21 years, and during the whole of that period had kindly acted as our local honorary secretary in Spain, the duties of which office he performed with great assiduity; Colonel Hoskjor, of the Danish Royal Engineers, had been connected with the Institution almost from its formation; Mr. F. L Pope's sad death was specially alluded to at the last meeting; Messrs. Edwards, Greener, and Muirhead, as well as that distinguished officer, Major General Stotherd, R.E., were among the original members of the Institution, and the latter was a member of its first Council Four foreign members, nine members, 21 associates, and 11 students have resigned during the year.

Besides the interesting and highly practical address of the President, papers dealing with nearly every branch of electrical engineering have been read during the year.

In respect to the papers read at the ordinary general meetings during the sessions 1894-95 the Council have made the following awards: the Institution Premium, value £10, to Mr. Mark Robinson (member), for his paper "On the Recent Development of the Single-Acting High-Speed Engine for Central-Station Work"; the Paris Electrical Exhibition Premium, value £5, to Prof. Ewing, F.R.S. (member), for his paper "On a Magnetic Tester for Measuring Hysteresis in Sheet Iron"; The Fahie Premium, value £5, to Mr. J. H. Kingsbury (associate), for his paper "On the Origin and Development of the Telephone Switchboard"; the Students' Premium, value £3. 3s., to Mr. A. C. Eborall, for his paper "On Single-Phase Alternate-Current Motors."

Partly owing to a balance of the scholarship fund remaining

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unappropriated last year, and partly to the generosity of Sir David Salomons in having this year added £500 to the capital of the fund, the Council are enabled to grant two scholarships of £45 each, and these they have had pleasure in awarding to the following gentlemen: Percy Rhodes Cobb, of King's College, London; Joseph Ernest Petavel, of University College, London.

The general rules for prevention of fire risks from electric lighting drawn up by the Council in 1883, and remodelled in 1888, having by the reason of great advance made in electric lighting become in some respects practically obsolete, a committee of the whole Council have been and are still engaged in their complete revision, and the new rules will, it is hoped, be ready for issue next year.

The recent meeting on the subject of the revised regulations under the Electric Lighting Acts, 1882 and 1888, so admirably presided over by Sir Courtenay Boyle, affords further proof of the desire of the Board of Trade to learn the views of the profession and to meet those views so far as is consistent with their duty to the public. They have consulted the Council of the Institution on important matters on more than one occasion during the past year.

The attendance of members and their friends at the conversazione held at the Royal Institute of Painters in Water Colours on July 3 was, as usual, very large.

Out of the surplus receipts of last year, the Council, as they anticipated, have been able to place the sum of £500 to the credit of the building fund, which now stands at £3,500, and they hope to add a further £500 out of the current year's surplus.

The financial position of the Institution is satisfactory, and the annual accounts, when made up to the end of the year, will in all probability show a surplus equal to that of last year. The following investments have been made during the year—viz, £554. 17s. 8d. on account of life compositions, and £1,099. 19s. 6d. on account of general investment fund.

The roll of the members and associates of the Institution is being continually augmented from the ranks of the large number of engineers who are now employed in the large electricity supply works which are being started in almost every town throughout the United Kingdom. Up to the present time 126 of these works are in operation, employing between 150 to 200 engineers, of whom the large majority are either members or associates of this Institution.

The large number of electro-chemical and electro-metallurgical works which are being opened in those parts of the country where fuel is cheap, and power can consequently be supplied at small cost, are also employing a very large number of our members.

An immense field will doubtless be afforded for the employment of electric engineers by electric traction, which, it is true, is yet in its infancy in this country, but there are signs that during the next few years this Institution will have its ranks largely increased from this source, as in the United States of America. Engineers engaged in electric railway work form a very large percentage of the members of the electrical profession.

The Council believe they are therefore not only justified in congratulating the members on the general position of the Institution, which so largely represents every branch of the profession, but that they are warranted in expressing the opinion that new and important opportunities are about to be afforded both in the United Kingdom and in our Colonies for the exercise of the skill and ingenuity of the electrical engineer.

The Chairman, in moving that the report be adopted and printed in the *Journal of the Proceedings*, thought the Institution might congratulate itself on having been one of the means of bringing the profession into line in reference to the important matters which had been discussed at the recent Board of Trade conference on electric lighting rules with such a satisfactory result.

Dr. John Perry seconded the motion.

Mr. J. S. Raworth wished to say a few words before the report was adopted. He could congratulate the Institution and the Council upon the report, and upon the prosperous position which it showed them to be in. But he thought it was a matter of regret that that report had not asked for greater powers for obtaining the advice and opinions of members upon matters affecting the welfare of the Institution. He was sure, in saying this, that he was representing the feelings of a large part of the members of the Institution, and that being so his sense of responsibility was commensurate with the subject with which he was about to deal. They had at the head of the Institution a Council of which they were all proud, and which was an honour to the Institution and to the profession; but there was a great defect in the mutual relationship between the Council and the body of the Institution. In fact, the Council and the Institution were two separate entities, each of which pursued its own course without knowing the desires of the other. The Council and the Institution resembled a pair of twins which came into the world together, but of which each from that date lived its own life and developed in accordance with its surroundings, so that after 20 years or so, when they were grown up, it might be that nobody would suppose them to have had the same parents. The Institution of Electrical Engineers came into existence 23 years ago, under the presidency of Mr. C. A. Siemens, with a Council and a membership of about a hundred, and in growing up together the want of correspondence between the Council and the members might some day culminate in an actual and tangible danger to the welfare of the Institution. He was sorry to say that if among the body of the members there existed a man who took so great an interest in the progress of the Institution that he not only held opinions, but expressed them, and those opinions did not happen to agree with those of the Council, that man was liable to be called a malcontent. It had happened so. He would call attention to the fact that when there was a question at issue between some of the members and the Council, or at all events some of the Council, it had seemed a proper course to some of those members to call upon the Council in order to represent their views. It would scarcely be believed that they had very great difficulty in even getting the ear of the Council for their representations. And when they did so, the first question put to them was, Whom do you represent? Now, in a case like that, although a man may be certain or nearly certain that he represents the views of almost everyone else in the Institution, he can only formally answer that he represents himself. He (Mr. Raworth) thought that if it was believed that the Institution did run any risk owing to the fact that the Council were not thoroughly in touch with the feelings of the members, then some measures ought to be taken by which, without resorting to the clumsy expedient of a general meeting, the Council could ascertain at any time the feelings of the members and under special conditions could take their advice. For that purpose he intended to propose a committee. Now, it would naturally be urged that the Council was a representative committee. In reality, however, it was not. The Council consisted of 15 movable members, four vice-presidents, and 13 past-presidents, so that in reality there were 17 stuck-fast and only 15 active and lively members who had any communication with the members of the Institution at large, or who had been drawn within a reasonable period from the ranks of those members. In the Institution of Civil Engineers, the owners of the building in which they now met, the past-presidents did not vote on the Council, so that they (the Electrical Engineers), though the younger institution of the two, had actually a more rampant House of Lords than their seniors, with this result that it did not matter what members they put upon the Council to represent them, as the irremovable past-presidents could always outvote them. It followed, therefore, that the Council could not be said to represent the members in the sense that a committee would. Now, they had that evening had placed in their hands a ballot-paper which ought to be a source of congratulation to everyone in the room. In presenting for election Mr. Sydney Morse, the Council had got on to bed-rock. Mr. Morse occupied pretty much the same position between themselves (the Electrical Engineers) and the Board of Trade that the committee he was proposing would occupy between the Council and the members.

The Chairman said Mr. Raworth must confine himself to the subject of the report. In speaking of the composition of the ballot-list he was certainly travelling outside that.

Mr. Raworth said that in that case he would only mention the satisfaction expressed by everyone at the selection of Dr. John Hopkinson as president. In that matter the Council had made a big score, though he could not say they had made it off their own bat. They had borrowed for once the bat of the Institution, and he hoped they would continue to use it. He moved, "That this meeting considers it desirable in the interests of the Institution to form a committee to represent the views of the members in consultation with the Council, and that such committee is hereby constituted with the following members: Messrs. A. A. C. Swinton, R. P. Sellon, W. P. Fawcus, A. B. Holmes, A. W. Heaviside, H. A. Mavor, J. C. Vaudrey, and E. Manville, with power to add to their number."

The Chairman: Is this a resolution or an amendment to the report?

Mr. Raworth said he was quite willing that it should be put as a resolution after the report.

The report was then carried unanimously, and **Mr. Raworth** rose immediately and filled in the names to the resolution as above, when

Mr. G. L. Bristow (the honorary solicitor) said the resolution was not within the power of the meeting. Under the wording of Clause 55 of the articles, the business of the annual general meeting was to receive and deliberate upon the report of the Council upon the state of the Institution, and to elect the officers for the ensuing year. That was the only business that could be brought before the meeting. Mr. Raworth's resolution must be brought forward at an ordinary general meeting after notice given. It was altogether beyond the powers of the meeting to entertain it at present. He would suggest that the resolution might be sent to the Council with a request that they should consider the best way to bring it forward.

Prof. Perry: Our difficulty is this, that you, sir, gave the meeting the idea that it might either be brought forward as a resolution or as an amendment.

The Secretary, who was standing beside Prof. Perry, was understood to say that he asked Mr. Raworth if he preferred to move it as an amendment or a resolution.

Prof. Perry: Sir, I say you did not; it was the President who spoke. In all fairness, Mr. Raworth should have the right to consider this either as a motion or an amendment to the report.

The Chairman said, when there was any doubtful point, the natural course was to refer to the honorary solicitor and ask what was the legal course to pursue. Their solicitor said that the safest way was to bring the resolution forward at a general meeting. What would be the use of himself or anyone unlearned in the law flying in the face of that advice? Mr. Raworth's object would be best obtained by following the course recommended.

Mr. A. A. Campbell Swinton thought the matter could be discussed since it referred to "the state of the Institution."

The Honorary Solicitor said if the members wished to express their opinions he thought they might do so, but it would be out of order to pass the resolution.

The Chairman suggested that if the question were postponed the meeting could proceed to discuss more interesting matter.

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Mr. Mavor thought no matter could be more interesting to the meeting, and **Mr. Swinton** agreed with this.

Mr. Raworth said he had been caught in a trap. He was naturally indisposed, if his object could be otherwise obtained, to carrying an amendment to the report, since that course had the appearance of a vote of censure. The effect of the action of the chairman had been to prevent that general meeting going on with the question, and had placed him and those that thought with him at a very great disadvantage.

The **Chairman** said, if Mr. Raworth had been trapped, it was accidentally. He (the Chairman), when he spoke, was certainly not aware of the effect that would follow. The advice of the solicitor was not given until after he had spoken. It, however, certainly appeared to him very inconvenient to discuss the question now and finish it some other day. He did not think the present one was a particularly large meeting. They would get quite as large a meeting to discuss it if they postponed the matter to the beginning of next year.

Mr. Raworth thought, if it was not possible to take a vote, it would be no use going on with the discussion. He, however, suggested that members present might give some little indication of their views in the usual manner, and this was followed by considerable applause.

Mr. H. W. Handcock remarked that the matter was one that could scarcely be settled in a single night. If it was to be decided at the next meeting it would be well to discuss it at the present meeting, so that members might have some idea of what was to be said for the proposition and against, and time for consideration. It might be that if they settled upon this committee to advise the Council, the next thing to do would be to appoint a second committee to advise the committee He thought rather they might follow the practice of the Institution of Civil Engineers. It was possible that some of the members moved in different circles to those in which the Council moved, but if it could be arranged that the past-presidents did not vote on the Council, and if the method of electing the council were slightly modified, it would be possible for the members to be properly represented there. They would thus still retain the experience of the past-presidents, and yet the Council would be representative of the ideas of the members of the Institution He thought it would be far better to continue the discussion than simply to spring a resolution upon a meeting to be settled perhaps in half an hour.

The **Chairman** said the best course would be to put it to the meeting whether the discussion should continue or be postponed, and, this being done, the show of hands was in favour of continuing the discussion.

Mr. Raworth proposed to put the meeting in order by moving that the meeting invited the President to call a special meeting to discuss the discussion.

The **Chairman** said that it was only necessary to get 10 members to request a general meeting, and the Council must call one within seven to ten days of the requisition.

Mr. H. Brat Harrison remarked that there was great difficulty at the present time in the way of any member bringing a suggestion before the Council. The knowledge any individual member could have of the general feeling of the Institution was confined to what he learned from his personal friends, who necessarily formed but a small portion of the whole list of members When a member found that among his own friends a certain change was desired, he could only speak in an informal manner to some member of the Council whom he happened to know, and under the circumstances he naturally appeared to represent only a very few members. If a committee were appointed that difficulty would be got over, as each member of the committee would be more or less the representative of a great number of members, and the Council would know that anything they proposed did not represent merely the views of a small clique. He did not, however, think it would be possible that evening, or in any one evening, to bring before the Council all the suggestions which members would now like to make, and that was why they wanted a committee who in the future could bring before the Council the various suggestions as they arose. The deliberations of the Council were private, and it might happen that the committee would have to bring before the Council certain matters which it would be well should not be brought forward in that room at what was practically a public meeting. He therefore supported the proposal.

Mr. Shoolbred suggested that it would be interesting to know how far the practice of the Institution in this matter was in accordance with that of other professional and learned societies He thought there might be a direction to the committee to ascertain the position of things in this respect

Mr. A E. Mavor thought he had perhaps more opportunities than many of them of meeting members of the profession who were scattered over the country or even in London and who never reached that hall. Without wishing to go beyond the subject of the discussion, he did not think that they were entitled to congratulate themselves as they had done in the report on the accession of members to their body. There were many active and energetic members in the profession who did not belong to the Institution, and did not care to belong. The past presidents, by their very eminence, were apart from the body of the members. The desire that the Council should take the younger members more into consideration was one that in his opinion, ought to be acceded to. He had no experience as to what a contested vote on the Council was like, but he did not believe for a moment that the past-presidents would oppose a general wish of the Institution All he asked was that the Council should know better what those wishes were, and that he asked in the name of the younger members of the profession. This was not the first time in the history of the Institution that circumstances had disarmed their action in the matter, and he thought that their articles of association ought to be so altered that they could understand them. Legal advice was doubtless very valuable, but it was much more valuable to know enough of the law to be able to do without your lawyer. He thought the articles should be put in plain English that everyone could understand.

Mr. G. L. Addenbrooke said that he considered that the matter had been sprung upon the meeting without due notice. A committee formed to represent the members might take far too much upon themselves. He had had experience of a somewhat similar experience in connection with the Photographic Society, of which he was a member. A committee was appointed on somewhat similar lines and after a long series of discussions, extending over a whole year, it had drawn up most democratic rules which had been a stumbling block in the way of the progress of the society. By these rules almost every matter had to be referred to the members, and hence a great deal of expense had to be incurred in printing and circulating notices. The continued waste of time caused a feeling of disgust amongst the members, and finally the repeated notices were neglected entirely.

Mr. R. S Erskine, speaking of the present method of electing the Council, complained of the short time allowed between the time the list was issued and the date of the election. He said there was practically no time allowed to organise an opposition after the list was made public. He would suggest that the names of the gentlemen proposed by the Council should be exhibited at the offices of the Institution at least six weeks before the date of the election

Mr. A. A. Campbell Swinton supported the last speaker, and rebuked Mr. Addenbrooke in a most dignified manner. He said they did not wish to follow in the steps of any Photographic Society, but rather to learn from the senior engineering societies, such as the Institution of Civil Engineers or the Institution of Mechanical Engineers Unless the list of proposed new members of the Council was published earlier than at present, it was impossible to take concerted steps to modify the list at the election. while without concerted action the ballot could effect no useful purpose. He understood that in the case of the Institution of Mechanical Engineers the list was made public a month or more previous to the ballot papers being sent out, and he thought that the Electrical Engineers might follow this example with advantage.

Mr. J. Hardie McLean thought that the opposition were taking up a false position. They demanded six weeks' notice for the Council list, but had not given six minutes' notice when springing the resolution on the meeting. The gentlemen who had spoken might have the support they talked of from some of the members, but at least they had not approached him in any way to learn his views, and he was not prepared at a moment's notice to give his vote one way or the other, and demanded proper notice to consider this important question.

The discussion was then closed by the **President**, who said that the matter would need careful consideration.

The usual votes of thanks to retiring officers were then proposed and seconded.

The **President** then announced that the whole of the gentlemen on the balloting lists were elected, and adjourned the meeting till January 16 1896.

THE PHYSICAL SOCIETY.

A special general meeting of this society was held on December 13, Prof Reinold, vice-president, in the chair.

The resolution with reference to the change in the amount of the life-composition fee passed at the special general meeting held on November 22 last was confirmed.

The ordinary meeting was then held.

Dr. John Shield read a paper on "**A Mechanical Device for Performing the Temperature Corrections of Barometers.**"

A paper by **Prof. Rucker** on "**The Existence of Vertical Earth-Air Electric Currents in the United Kingdom**" was, in the absence of the author, read by **Mr. Kay**. In a paper read before the British Association at Oxford, Dr. Schmidt stated that he had expanded the components of the earth's magnetic force in series, and had deduced expressions, two of which give the magnetic potential on the surface of the earth, in so far as it depends on (1) internal and (2) external forces. The third series represents that part of the magnetic forces which cannot be expressed in terms of a potential, but must be due to electric currents traversing the earth's surface. Dr. Schmidt concluded that such currents amount on the average to about 0·1 ampere per square kilometer. The author has tested this conclusion, drawn from the state of the earth as a whole, by means of an examination of the line integral of the magnetic force taken round a re-entrant circuit, taken in the United Kingdom. The necessary data have been obtained from the results of the magnetic surveys for the epochs 1886 and 1891, carried out by the author and Dr. Thorpe. Two circuits, called the α and β circuits, were selected, having their greatest extension N. and S. and E. and W. respectively. The work done by a unit magnetic pole on traversing these circuits was calculated for the epoch 1886 by means of the terrestrial lines found for that date, and also for the epoch 1891 by means (1) of the same lines when due allowance was made for secular change, and (2) of the independent set of lines found by aid of the 1891 survey. The same calculation was made for a third circuit (γ), using instead of the calculated terrestrial lines the true values of

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the forces and declinations as deduced from the nearest stations. The following table gives the results in amperes per square kilometre:

	α	β	γ
1886	−0·026	−0·004	—
1891 (1)	+0 001	−0·005	—
1891 (2)	--	—	−0·008

From these figures the author concludes that there is not in the United Kingdom at any rate a vertical current amounting on the average to 0·1 ampere per square kilometre.

Mr. Watson said a few words on the difficulty experienced in determining the line integral in South Wales due to the presence of closed curves.

The society then adjourned till January 24, 1896.

LEGAL INTELLIGENCE.

NORTH METROPOLITAN TRAMWAYS COMPANY v. THE LONDON COUNTY COUNCIL.

The Master of the Rolls (with Lord Herschell and Lord Justice Kay) has heard an appeal by the North Metropolitan Tramways Company from the judgment of Mr. Justice Romer, in May last, holding that the London County Council were entitled to compulsorily purchase so much of the plaintiffs' tramways—and, consequently, so much of each separate London tramway scheme—as is within the Council's district, without purchasing the whole of the undertakings as one concern. The separate schemes, it was argued below, had legally been amalgamated into one undertaking, and consequently the time for compulsory purchase would not arrive until the expiration of 21 years from the last constructed of the series, instead of, as the County Council submitted, their being able to purchase each separate undertaking within this period after its becoming an accomplished fact.

Mr. Cripps, Q C., appearing for the company, argued for nearly two hours upon the grounds he enforced before Mr Justice Romer, but which the learned judge rejected—that by the appealing company's special Act of 1890 a parliamentary bargain was made which, in the peculiar circumstances of the case, fixed the time at the expiration of which the local authorities might compel the different companies to sell their tramways at 21 years from the passing of the respective Acts instead of from the passing of the general Act of 1870 dealing with the subject.

At the close of the learned counsel's submissions, without calling on Sir Edward Clarke, Q C., who, with Mr. Fletcher Moulton, Q C , appeared for the London County Council, each of their Lordships, speaking at some length, dismissed the appeal, each, in effect, holding that the rule of construction applying to a private Act was that it could not alter a public Act except by express words, which words were not included in the appealing company's Act in this case, and that a private Act must be held to have the same meaning as the general one unless there was something in the subject repugnant to such construction.

Lord Herschell took the same view as to the rule of construction and the effect of adopting Mr. Cripps's suggestion, and **Lord Justice Kay** concurring, the appeal was dismissed.

COMPANIES' MEETINGS AND REPORTS.

SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED, IN LIQUIDATION.

The final meeting of the shareholders of this Company was held on Tuesday, the 17th inst., at the offices of the Company, to receive the liquidator's accounts of the winding up of the Com pany, Major S Flood Page, in the absence of the chairman (Mr. James Staats Forbes), presiding.

The **Chairman** said: We meet, not really to bury the pioneer of electric enterprise for it is not quite dead—phœnix-like, again it rises from its ashes in the Edison and Swan United Electric Light Company, Limited. Those of us who can go back to the time of the inauguration of the Swan Company can realise what a very great work in this country was done by it. It must be a gratification to you, as it is to us all. to know what probably not many of you are aware of, that Mr. Swan began his investigations in connection with the electric light in the year 1845, and it is a pleasure to know that he is still among us, giving us invaluable aid and assistance in the work that we have to do now. It is interesting to think that Mr. Swan should have been able to keep working for the Company so many years, and to live to see the marvellous change which has been brought about by the introduction of the electric light. We have some gentlemen here present who took an active part in the formation of the old Swan Electric Lighting Company. That was at the time when lamps cost 17s. 6d. each to make, and were what we should now consider to be of very poor quality. Then we come to the time when the price was reduced to 12s. each, and that was looked upon as an enormous advance, but now we are selling lamps at 1s. 9d. each in the face of great competition.

The **Liquidator** then presented his statement of the distribution of assets, and it was resolved, "That the accounts submitted to this meeting, and showing the manner in which the winding up has been conducted, and the property of the Company disposed of, be received and adopted, and that the books and papers of the Company and of the liquidator be handed over to the Edison and Swan Company."

Mr. Swan seconded the resolution, and said that it was always a melancholy thing to assist at a funeral, but the chairman had been pleased to speak of its resurrection in the Edison and Swan Company. The remarks of the chairman had aroused in his recollection many interesting reminiscences of the vicissitudes of the Company, the old Swan Company—and the Swan United Company—and he was glad that he had been able to assist in giving the people a more wholesome and a better light than before. The changes of the companies which had taken place had not always been agreeable to him, but he had not opposed them, because he had supposed them to be in the interest of the shareholders: in a number of instances he had suppressed his own feelings and his own interests, in order that a better chance of success might be given to the Company. He believed that the Edison and Swan Company had a long and prosperous career before it.

The resolution was then put, and carried unanimously.

FROGGATT'S ELECTRIC LIGHTING COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on Monday at Winchester House, Old Broad-street, E.C., Mr. C. de Murrieta presiding, to consider resolutions for winding up the Company and appointing Mr. W. P. Eldrid, chartered accountant, liquidator.

The **Chairman** expressed regret that, in consequence of the failure of their efforts to obtain further capital, it had become impossible to carry on the business. He regretted this the more because everything pointed to a promising future provided that certain modifications in the working and administration of the Company were carried out. He need not trouble them with a recital of the difficulties with which they had had to contend—difficulties which were inherent to every pioneer enterprise. He would only say that they had earnestly laboured without reward in the interests of the Company, and had at least shown that the system adopted by the Company was well conceived, and in happier circumstances might still achieve success. But all the available funds being exhausted, and no response having been made to the proposal for issuing preference shares, the best, and, indeed, the only course to pursue was to wind up the Company, and it was suggested that Mr. Eldrid, their auditor, should be appointed liquidator. That gentleman was acquainted with the working of the Company, and was thus well qualified to judge of the best means of disposing of the assets, or, if possible, the manner by which a reconstruction might be effected.

Mr. Philip Hall said it was a very serious matter for the shareholders that in about 12 months' time a company like theirs should have to be wound up, and he hoped that something might be done either to reconstruct it or to sell its rights to a larger company, which would be more likely to make the enterprise a success

The **Solicitor** (Mr. W. L. Cooper) stated that efforts had been and were still being made with the object mentioned, and it was hoped that the liquidator might be able to carry those efforts to a successful issue. It was, however, necessary to take the steps now proposed, or the assets of the Company would be dispersed by execution creditors.

On the motion of the **Chairman**, seconded by **Mr. Froggatt**, resolutions in accordance with the object of the meeting were unanimously passed.

BRITISH STEAM GENERATOR AND REFUSE UTILISATION COMPANY, LIMITED.

At the Companies' Winding-up Offices, Carey-street, E.C., last Friday, the meeting of the creditors and shareholders of the British Steam Generator and Refuse Utilisation Company, Limited, was held before Mr. Winearls, assistant provisional liquidator. The Company was formed in June 1893, with a nominal capital of £600,000, for the purpose of acquiring patents for furnaces for the destruction of refuse of large towns, the resulting forces produced therefrom being used for the production of cheap electricity or the generation of steam power. The purchase price was to be £470 000 in fully-paid shares and £30,000 in cash. The vendor, the executrix of the patentee, however, alleges that she has only received £286 in cash Some £216,590 of shares have been allotted, in respect of which no cash was received by the Company; and further, one of the patents has lapsed owing to the money paid to satisfy the patent fees being used by the person to whom it was paid for other purposes

The **Chairman** stated that in September, 1892, an installation was set up at Halifax to show the utility of the invention and the wonderful revolution which was going to be worked in the utilisation of refuse It was reported favourably upon in the provincial Press. From statements made by Mr. Glaskin, it appeared that a report he had addressed to the directors had been used by the promoter as a means of obtaining cash advances from various persons, and that those persons had notified the Company that they claimed a charge in respect thereof on part of the share capital Representations had been made to the Official Receiver that in some case the advances were made on the distinct understanding that they would be applied in pushing the invention with a view to the Company being formed. On the other hand, it was stated that those advances had been made to the promoter personally, and not as representing the Company. The only assets

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of the Company consisted of the three patents, the installation at Halifax, and 100,000 shares in the London Refuse and Steam Generator and Electrical Power Corporation, Limited, already held by creditors for advances. The details of the liabilities had not yet been obtained, but they were roughly estimated at £2,500, in addition to the liability to the vendor.

After a short discussion it was resolved to leave the winding up in the hands of the Board of Trade.

DUBLIN SOUTHERN DISTRICT TRAMWAYS COMPANY, LIMITED.

A special general meeting of the shareholders in this Company was held on December 11 at Clare-street House, Bristol, Mr George White, chairman of the Company, presiding.

The **Chairman** explained the proposed extensions of the Company's system in Dublin, and the necessity for further capital, all of which would be subscribed by the present shareholders, and it was unanimously agreed to increase the capital as recommended by the Board.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Brumath.—The Town Council invite tenders for lighting the town by electricity, steam power to be used. Conditions from Bürgermeister A. Bostetter, Brumath-i-Els., Germany.

Orduna.—The municipal authorities invite tenders for the execution of a waterworks and electric lighting scheme. The estimate is 84,729 pesetas. Particulars of El Ayuntamiento de Orduna, Spain.

Betanzos.—Tenders are invited by December 28 for the concession of the electric lighting for 25 years of the town of Betanzos, Spain. Conditions of La Direccion General de las Administraciones Locales, Madrid.

Ploesti.—The Municipality of Ploesti invites tenders by January 15 for the lighting by electricity of the 46 principal streets in the centre of the town. Conditions from La Mairie de Ploesti, Roumania.

Brussels.—The Ministère de la Guerre invites tenders by January 15 for (1) a heating installation, (2) electric lighting in the new military school to be constructed in the Avenue de la Renaissance, Brussels.

Langeac.—The municipal authorities invite tenders for lighting the town by electricity during a period of 40 years. Water power is available. Specifications of M Grenier, conducteur des Ponts-et-Chaussées à Langeac (Haute-Loire), France.

Cleator Moor.—Tenders are invited for an electric light installation in the central stores of the Cleator Moor Co-operative Society. For particulars apply to Mr. J. C Teasdale, secretary, General Office, Co-operative Society, Limited, Cleator Moor, Cumberland.

Aussig.—The communal authorities propose to have built a seven-mile single line tramway. The choice of system is left open. Contractors are invited to place themselves in communication with the Stadtrath, Aussig a.-d.-Elbe, Prussia. Tenders are to be in by January 31.

Pernambuco.—Tenders for lighting the city of Pernambuco by electricity are invited by the Government of the State of Pernambuco (Brazil). Particulars may be had on application to the Brazilian Consulate-General, Liverpool, or to the Brazilian Consulates in London, Manchester, and Glasgow.

Dublin.—Messrs Arnott and Co., Limited, Dublin, invite tenders from competent firms for electric light and power installation to their new premises, Henry-street and Princes-street, Dublin. A copy of specification can be obtained from Mr. George P. Beater, M.R.I.A.I., architect, 17, Lower Sackville street, Dublin, on payment of £5. 5s., which will be returned on receipt of bona fide tender, which must be delivered at architect's office on or before January 8, 1896, endorsed "Electric Installation, Arnott and Co., Limited.

Chelsea.—The Guardians of St. Luke, Chelsea, invite tenders for fitting up an electrical wiring installation, with fittings, in the Chelsea Infirmary extension, Cale-street, Chelsea. Particulars upon application to the Guardians' architects, Messrs. Lansdell and Harrison, 12, Compton-terrace, Highbury, N., on depositing with them £5, which will be returned to those sending bona fide tenders not later than 12 o'clock noon on December 31, 1895 addressed to Mr. Wm. Miller, clerk to the Guardians, Guardians' Offices, 250, King's-road, Chelsea, S.W.

Durban (Natal).—The Corporation desire tenders for the supply, for delivery at Durban, and fixing at Durban, of steam and electrical plant for the lighting of the borough by electricity. The work will be executed under the direction of Mr. Fletcher (borough engineer) and Mr. Hadfield (electrical engineer) at Durban. The plant required includes high-speed engines, dynamos, cables, arc and other lamps, accumulators, etc. Specifications and plans can be obtained from Mr. W. H. Radford, C.E., Angel-row, Nottingham, consulting engineer to the Corporation, on deposit of £5. 5s., which will be returned on receipt of a bona fide tender. Sealed and endorsed tenders, in duplicate, must be delivered at the offices of Messrs. Webster, Steel, and Co., agents to the Durban Corporation, 5, East India-avenue, Leadenhall-street, London, E.C., by 28th inst.

RESULTS OF TENDERS.

Hampstead (London).—The Vestry have accepted the offer of Messrs. Siemens Bros, of Queen Anne's-gate, to take entire charge of the arc lamps in Finchley-road for a period of eight weeks, providing all necessary carbons and labour for trimming, etc, for the sum of £35. 10s.

Bradford.—On the recommendation of the Gas and Electricity Supply Committee, the Corporation have accepted the offer of Messrs George Scott and Son, of Liverpool, to supply and fix at the chemical works, Frizinghall, for the sum of £1,350 a plant required in an extension of the works.

Llandrindod Wells.—The Urban District Council have resolved to accept the offer of Mr S Jevons, of Birmingham, to carry out the work of lighting the town by electricity. The price tendered was 45s. per annum each for 70 incandescent public lamps of 32 c p. for eight months of the year, to burn from dusk to 11 p.m. Mr. Jevons will provide all cables and fittings, utilising the present lamp columns as far as possible, but the ratepayers will have to pay about 3s. 6d. per lamp per annum for new lamps, repairs, etc., and also the cost (about £200) of burying the cables if overhead wires are objected to.

BUSINESS NOTES.

Southwick (Sussex).—The inhabitants of Southwick village have adopted the Lighting Act.

Nantwich (Cheshire).—The Urban District Council have expressed themselves dissatisfied with the present gas-lighting.

Eccles (Manchester).—A meeting of ratepayers has protested against the proposed introduction of the electric light into the borough.

Whitehaven.—The Town Council have requisitioned Dr. Hopkinson to advise them in connection with the existing electric light installation.

Stirling.—The Police Commissioners who have obtained an electric lighting order, are now proposing to approach the gas company with a view to purchase.

Wolverhampton.—The sanction of the Local Government Board has been received for the Corporation to borrow another £5,000 to extend the electric lighting works

Reading.—The Reading Installation Company, of the Arcade, have issued a special illustrated catalogue setting forth the advantages of electricity as an illuminant over gas.

Catalogues.—Messrs. Clarke, Chapman, and Co., Limited, of Victoria Works, Gateshead-on-Tyne, forward us a copy of the 1896 edition of their well got up catalogue of electrical machinery and appliances.

Shrewsbury.—In consequence of support already received and promises given, the directors of the Shropshire Electric Light and Power Company have reduced the retail price of their commodity from 8d. to 7d per unit.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended December 15 amounted to £1,081, as compared with £917 in the corresponding week of last year, being an increase of £164

Devonport.—The corporate seal has been affixed to a memorial in support of the application to the Board of Trade for a provisional order for the supply of electricity within the borough for public and private purposes.

Brush Electrical Engineering Company, Limited.—The transfer books of the 4½ per cent. second debenture stock are, in view of the interest payable on January 1, 1896, closed from December 18, 1895, to January 4, 1896.

Ashbourne (Derby).—Plans and sections of the Derby and Ashbourne Tramway, relating to the part to be constructed within the urban district, have been laid before the Urban District Council, and were referred to the Highways Committee.

St. Austell (Cornwall).—The Urban District Council have instructed the Lighting Committee to prepare a specification on which the electric light and gas companies might be invited to tender for the lighting of the principal streets.

Hornsey (Middlesex).—The Lighting Committee of the District Council have recommended "that the application of an engineer in reference to the lighting the streets and buildings in the district with electricity cannot at present be entertained."

Stonehouse (Plymouth).—The *Western Morning News* says that if the gas company "want to encourage promoters of electric light undertakings they cannot do better than continue to supply poor gas, and little of it, as they have done this week."

Bonsall (Derby).—The Urban District Council have resolved that enquiries of various firms be made as to the cost of the construction of plant for the manufacture of gas and for electric lighting for the requirements of a district with a population of 2,000.

Wakefield.—Alderman Sherwood, in moving the adoption of the Electric Lighting Committee's report, said they were getting on as rapidly as possible, but would not be able to proceed much further until the Sewage Committee had decided as to the site.

Watford.—Councillor Andrews has given notice that he would at the next meeting of the Urban Council move that a committee be appointed to consider the advisability and practicability of applying for a provisional order under the Electric Lighting Act for Watford.

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Metropolitan Electric Supply Company, Limited.—Payment by warrants will be made on January 1 next of interest for the half-year ending December 31 on the 4½ per cent. first mortgage debenture stock The transfer-books are closed from the 18th to 31st inst., both d ys inclusive.

Electric Insulation Syndicate, Limited.—This Company has been registered. Capital £5 000, in £10 shares. Objects: to enter into an agreement with J. P. Whitaker and F. G. Treharne for the acquisition of certain patents, and to develop and turn to account the same in such manner as the Company shall see fit.

Withington (Lancs.).—In the last minutes of the General Purposes Committee of the Urban District Council it was stated that the surveyor had submitted tenders which he had obtained for the electric lighting of the Town Hall throughout. The Council resolved that the matter should remain in abeyance until Aprli.

Islington (London).—It has been stated at the meeting of the Vestry that the contractor for engines, boilers, and steam plant has definitely promised that the machinery shall be running by the 31st inst., and that the official test will be immediately applied, and the supply of electricity made available on January 1, 1896

City and South London Railway.—The returns for the week ended December 15 were £1 014, compared with £962 for the corresponding period of 1894, being an increase of £52 The total receipts for the half-year 1895 were £21,541, compared with £21,480 for the corresponding period of 1894, being an increase of £61.

Metropolitan Asylums Board.—We learn that the order for the steam-engines for the Brook Hospital has been given to Messrs G. E. Belliss and Co, Limited, of Birmingham. It speaks well for the Belliss double-acting, self-lubricating engine that an exception has been made in its favour to run at a speed specified for single-acting engines.

Bangor (co. Down).—A special meeting of the Town Commissioners has been held for the purpose of considering the advisability of applying to the Local Government Board for a license to have the town lighted with electricity, and it was resolved that the cost of obtaining the license be ascertained before a decision was adopted.

York.—The Streets and Buildings Committee of the Corporation have received a letter from Prof Kennedy accepting the conditions under which the committee desired him to act as adviser to them on the question of electric lighting for the city. Prof. Kennedy further intimated that he would fix an early date to make a survey of the city for the purposes of his report.

Coventry.—The Estates and Finance Committee have reported to the Town Council that the adoption of the electric light for the free library is quite beyond their means, and the only course open is to place the matter before the Estates and Finance Committee and ask their assistance The sum required is £140, and the committee recommend that it be provided out of the borough fund.

Bolton.—The electrical engineer (Mr. J. H. Rider, M I E.E) has been instructed by the Gas and Electricity Committee of the Corporation to prepare a report and estimate of the cost of the extensions necessary to be made in the plant at the electricity works. In his report to the committee the engineer stated that 96 consumers were now connected, and that five others would shortly be ready.

Sheffield.—Since the last Council meeting the future of the Sheffield tramways has been the talk of the town, and the interest manifested in the matter is increasing. Mr. W. Page, the engineer of the syndicate which proposes to establish the extensive system of electric trams to supersede the present inadequate arrangement—should Parliament allow them to do so—has been in Sheffield engaged in the preparation of the estimates.

Fleetwood.—Respecting the proposed electric tramway between Fleetwood and Blackpool the Urban District Council have received a letter from the promoters of the scheme enclosing statutory copies of the notice of the proposed application to next session of Parliament for powers, and asking the Council to signify whether they assented to, dissented from or were neutral to the same; and it was decided to reply that the Council remained neutral.

Cheltenham.—One of the Corporation employés has met with his death whilst engaged in one of the transformer-chambers in the centre of the town. The man, John Pugh, about 28 years of age, and belonging to Wolverhampton, previous to coming to Cheltenham about four months since, was in the employ of Messrs. Callender and Co, and was considered a skilled workman. It is presumed that the unfortunate man had neglected to take the precautions usual under the circumstances.

The Eastern Telegraph Company, Limited.—The directors announce the payment, on January 14 next, of interest of 3s. per share, less income-tax, being at the rate of 6 per cent per annum, on the preference shares for the quarter ending December 31, and the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income-tax, in respect of profits for the quarter ended September 30. The transfer books will be closed from January 7 to January 14, both days inclusive.

City of London Electric Lighting Company, Limited.—The transfer books of the debenture stock will be closed from 23rd to 31st inst., both days inclusive, for the purpose of preparing the warrants for the interest due January 1, 1896. Application has been made to the Stock Exchange Committee to appoint a special settling day in, and to grant a quotation to City of London Electric Lighting Company, Limited, provisional certificates of a further issue of £100,000 5 per cent. debenture stock.

Appointments Vacant.—The Salford Corporation have a vacancy for an assistant electrician for a central station. Applicants must have had experience of high-pressure alternating-current system, and be capable of testing cables, house wiring, transformers, and meters. The Lighting Committee of the Dewsbury Corporation have a vacancy for an improver, to act also as dynamo attendant, in their electricity supply station. Particulars will be found in our advertisement columns.

Bexhill (Sussex).—The Urban Council have adopted the following resolution: "That the Urban District Council of Bexhill hereby give their consent to an application by or on behalf of Robert Kersey and the Honourable Gilbert George Reginald Sackville, commonly called Viscount Cantelupe, to the Board of Trade for a license under the Electric Lighting Acts, 1882 and 1888, to supply electricity for public and private purposes within the whole or any part of the urban district of Bexhill, in the county of Sussex"

Ashton-under-Lyne.—The Town Council have resolved: "That the Mayor, Aldermen Andrew, Heginbottom, Hilton, Siddall, and Wilson, and Councillors Andrew, Catlow, Cooke, Hall, Hallam, Kelsall, A E Mellor, Newton, Phillips, and Shaw be appointed a committee to be called the Electric Lighting Committee, and that such committee be authorised to adopt such measures and to make and complete such arrangements as may, in their opinion, be necessary and desirable in order to carry out and give effect to the Ashton-under Lyne (Corporation) Electric Lighting Order of 1892"

Aberdeen—The Lighting Committee of the Aberdeen Town Council have decided to try the experiment of lighting the streets with electric overhead lamps. The lamps will be suspended over the middles of the thoroughfares on wires. The streets selected for the experiment are Broad street and Bridge-street. The Gas and Electric Lighting Committee of Aberdeen Town Council have agreed to place in the depôt, in Union-street, a few electromotors for exhibition. These are to be made to drive small sewing machines, etc., in order that the public might see to what extent electricity can be utilised.

Pupils.—We understand that the London Electric Supply Corporation have decided to take a limited number of pupils at a small premium. The custom of the corporation hitherto has not been to take premium apprentices, but owing probably to the valuable practical training received by the engineering staff, and the important appointments obtained by former employés, applications to be taken on the engineering staff have lately largely increased Doubtless these applications are mainly the result of the success which has followed engineers who have received their training with the corporation.

Queenstown.—The streets of Queenstown were left in a state of darkness on Saturday night and succeeding nights. This state of things is the result of a dispute between the Queenstown Town Commissioners and the local gas company. The latter body served notice on the Town Commissioners on the 11th inst. threatening to extinguish the lamps if the Commissioners did not enter into a contract for public lighting for a term of two years. The town clerk informed the gas company that the Commissioners could not legally deal with the matter until after the 14th inst. In spite of this the gas company have executed their threat.

Torquay.—The Town Council seem at last seriously determined to tackle the electric light question. They have only another six months before their provisional order expires, so that it is time they were up and doing Once again the whole subject is referred back to the Electric Light Committee, of which Alderman Kerswill continues chairman. The instructions to the committee are to make enquiries as to a suitable site for the station, apart from the Bath Saloons, to canvass the town for likely customers for the new light, and to call in another expert. Generally speaking, councillors are in favour of the introduction of electricity, but they fear a possible addition to the rates.

Copper.—Messrs. Henry R Merton and Co.'s fortnightly statistics show that, although the stocks of copper have declined by 170 tons since the end of November, the price of Chili bars has also fallen 5s. a ton. Notwithstanding rather larger supplies from North America, the deliveries exceeded the arrivals by 170 tons during the fortnight—which is satisfactory evidence of the continued growth of consumption At the present time the stocks of copper in England and France and afloat are only 45,561 tons—a smaller amount than has been recorded for many years past; yet there is the remarkable fact that on July 31, when stocks were 10,000 tons larger, the price was £47 a ton, against £42. 17s. 6d. now.

Gravesend.—The Works and Finance Committees of the Town Council conjointly, in reference to the letter of Messrs. Riley and Co, read at the last meeting, had before them a further letter from this firm, in which they stated they proposed to defer supplying the information for the present, as they found they were out of time to make a formal application for a provisional order until the autumn of next year. The Joint Committee were unanimously of opinion that "the application submitted to the Council had evidently been misconceived by Messrs Riley and Co, and that no inducement should be held out to such contractors to make any further application to the Council." The minutes were confirmed.

Linlithgow.—The Police Commission have received the report of the committee appointed to take into consideration the cheapest and most effective method of lighting the town, reported that "the present price of electric light was about three times the price of gas, but that certain improvements were being carried

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out at the present time which were thought would have a good effect in materially reducing the cost of electric light." The committee were also of opinion that nothing could be done with the taking over of the present gas company's works till the end of next year, and they, therefore, recommended that the matter be held over for future consideration. The Commission agreed to the committee's recommendation.

Buxton.—The Urban District Council have adopted the following report of the Electric Lighting Committee: "After full consideration the committee feel that, having in view the position of Buxton and the various advantages and disadvantages of electric lighting *versus* gas lighting, it is not desirable to take any steps to erect an installation in the town for the present They would suggest that the discussion be adjourned for 12 months, and that an application be made to the Board of Trade for an extension of the time when the powers under the Buxton Electric Lighting Order shall lapse." Councillor Willoughby said that he could only regret that the newly constituted Electric Lighting Committee had come to such an untimely end.

Bradford.—The Gas and Electricity Committee of the Bradford Corporation have had some cause for anxiety in regard to the exceptional demand for the supply of electric light which is expected to come at Christmas. Since the commencement of the Corporation installation there has hardly been a day when the committee could boast that it had satisfied all present applicants for the supply, and latterly it has been badly hampered by various misfortunes in connection with the putting in of additional machinery. Very special efforts, however, are being made to cope with the strain of the Christmas period, and, though new applicants have very little chance of obtaining a connection just now, it is hoped that the committee will be able to satisfy all present users.

The North Staffordshire Tramways.—On Wednesday, a meeting of representatives of Stoke, Hanley, Burslem, Longton, and Fenton, convened by the Stoke Corporation, was held at Stoke-on Trent for the purpose of discussing matters in connection with the North Staffordshire tramways. The meeting eventually passed the following resolution: "That this meeting is of opinion that the various local authorities within the district of the tramways company should combine in opposing the clause proposed to be inserted in the agreement with respect to the purchase of the electrical equipment of the company, and that the clause should be altered so as to read that in the event of the option of purchase being exercised the sum to be paid should be ascertained by arbitration."

Kingswood (Bristol).—A draft of the proposals of the Great Western Electric Light and Power Company, who are about to apply for powers to supply public and private electric light in the Kingswood district, has been brought before the Urban Council. Mr. Wilshire said he did not think they could possibly have a much worse plant than that now used for the electric light. Mr. Newman considered that the negotiations that had been going on as to the lighting of the district had not been over-expeditious. He had intended asking for an extension of the light in Church-road, where it was very much needed. The question was deferred until the next Council meeting, when the proposals of the new company to supply the whole of the area covered by the Council with their system of electric lighting will be considered.

Yarmouth.—The surveyor's monthly report as to electric lighting is again satisfactory. Since the last meeting applications have been received from 15 new customers for 580 lamps, making the total number of customers 135 for 6,369 lamps The income for November amounted to £308. 8s, and the expenditure to £164. 14s. 2d. Thus, the Council had earned £143. 13s. 10d. beyond the cost of the production of the light. From this have to be deducted repayment of capital and interest, rates and taxes, and depreciation—estimated at £90 in all To meet a very general request, the Council have instructed the surveyor to arrange as early as possible for supplying customers continuously. The Council have resolved to increase the salary of Mr. Ranken, who holds the post of chief engineer at the electric lighting station, to £200 a year.

Dynamo Brushes.—We have received from Messrs. F. W. Potter and Co., wire-weavers, wire-workers, etc, of Phipp-street, Great Eastern-street, London, E.C., a price list of their "Dovetail" copper gauze brush for dynamos and motors (Soar's patent) The "Dovetail" brush is made of copper wire gauze, so folded that the part intended to face the commutator consists of plain layers of gauze to the extent of about one half of the thickness of the brush, backed by about an equal quantity of gauze folded or corrugated at or nearly at a right angle to the plain layers, or without the plain layers of gauze; and the degree of stiffness given to the brush can be varied from the great flexibility of an ordinary wire gauze brush to almost the rigidity of metal. As to the advantages of this brush one customer of Messrs. Potter wrote that in his opinion, "It is the 'Dovetail' first, the others nowhere."

Liverpool.—"Regret" writes to the *Courier*: "How much longer will it be before the thoroughfares of Liverpool will be lighted by electricity? The municipal authorities seem inclined to sit down and worship the work of their illustrious predecessors, like the Chinaman. Meantime the 'great sea city' remains with stunted streets, lighted in the most ancient manner possible, and a pierhead graced by minute public-houses." The first experiment in the lighting of the Prince's landing-stage by electricity was made the other evening. Six arc lamps were erected upon temporary posts at equal distances from the office of the river police to the north end. The lights were turned on for a couple of hours, and were inspected by the dock engineer, the general manager, and a few members of the Dock Board. If the Board adopt the electric light—as no doubt they will—the illumination of the stage will then leave nothing to be desired.

Beckermet (Cumberland).—The Lighting Committee have reported to a parish meeting on the lighting of the village. The committee had obtained estimates for lighting by oil, which, with maintenance expenses, would involve a rate of from 3¾d to 2¾d. in the pound. As water power was available, they had also obtained an estimate from an electric light firm, according to which the plant would cost about £39, equivalent to a 2¾d. rate. There would be only 10 lamps of 16 c p. each, instead of 12 oil lamps, and the wires would be placed on posts, and, of course, they could not be at any time used for house lighting. It had been suggested by the committee that a practical man be asked to come to the village and give an estimate of what the electric light would cost with wires underground, and with sufficient power to supply any houses that might require it. The meeting after some discussion, decided not to adopt the Lighting Act.

Taunton.—The Electric Lighting Committee of the Town Council have reported that, in consequence of an additional 120 lamps being installed in South-street, it would be necessary to provide a new transforming station at East Gate in accordance with the estimate adopted by the Council at their meeting held on September 11, 1894. The Local Government Board had sanctioned the borrowing of the money. The committee therefore asked the Council to authorise them to take the necessary steps for carrying out the works and to obtain tenders for two new transformers Dr. Fleming visited Taunton on the 4th inst. for the purpose of inspecting and testing the switchboard supplied by Messrs. Newton, and also the engine and alternator supplied by the British Thomson-Houston, Limited. He met the committee on the 5th, and reported that the result of his testing was satisfactory. He promised a written report in a few days The committee's report was adopted.

Harrogate.—Mr. W. F. B. Clerke, C.E., has held the Local Government Board enquiry into the application of the Town Council for sanction to borrow £33,700 including £20,500 under the Electric Lighting Act for building, plant, etc In answer to the inspector, the Town Clerk said that the cost of obtaining the electric lighting order was £264, and they had spent in deputations and fees £750 The population of the borough was from 16,500 to 17,000, and it had practically doubled itself in 20 years. The ratable value was £109,000, and the total debt was £194,460. The Mayor urged the early and favourable reply of the Local Government Board in reference to the loans, as they were desirous of opening a portion of the new baths next season, and strongly desired the electric lighting installation to be in full working order by that time. The Inspector said that he should submit his report in about 10 days, and he should mention to the Board that the Town Council were anxious for an early decision.

Newington (London).—The report of the General Purposes Committee in respect to electric lighting has been submitted to the Vestry. The report recommends the Vestry to oppose the granting of a provisional order to the County of London and Brush Provincial Company to supply the parish with electricity for public and private purposes In the discussion which ensued Mr Davies reminded the Vestry that the adoption of an electric lighting scheme would involve an expenditure of many thousands of pounds, and said he did not believe in the municipalisation of everything. On the other hand, Mr. Westcott contended that as other parishes smaller than those of Newington had made electric lighting pay he did not see why they should not, and he urged that they should not commit the blunders of Leeds and Liverpool, which had been forced to buy out at a tremendous premium the companies to whom they had surrendered their provisional orders. The recommendation of the committee was then carried, and it was decided to apply to the Board of Trade for a provisional order.

Blackrock (Dublin).—The township engineer has submitted a report in reference to the state in which the roads were left by the contractors for the Main Drainage Board and the contractors for the electric tramway company. He stated that the Drainage Board left the roads at Seaforth-parade, Idrone-terrace, Tobernea-terrace, and Seapoint-terrace in a very rough condition, and although a little improvement had been attempted in some directions much remained to be done. The contractor had repaired the crossings at Alma-road, but not in a workmanlike manner. In reference to the tramway contracts, it was alleged that owing to the alterations of the levels of the roads all the crossings, with the exception of two, had been disturbed. Stones had been taken up and never replaced, the crossings left too high on one side and too low on the other, and in some places altogether too low. The cable trench throughout had never been properly rammed or finished, and was still in several places too high. The tramway officials had from time to time promised to have these matters attended to, but up to the present nothing has been done in reference to the crossings and very little as regards the cable trench.

Brighton.—The Works Committee of the Brighton Town Council have received a fresh application from the General Post Office with reference to the proposal to carry a line of overhead wires across Ship-street. It is pointed out that this is part of a work of national importance, in which such a town as Brighton must be considerably interested, inasmuch as the wires are intended to form a part of the "backbone" system of trunk telephones which the Department is now engaged in establishing in pursuance of the policy sanctioned by Parliament in the Telegraph Act of 1892. It was resolved by the committee "that

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under the exceptional circumstances of the case, the permission asked for be granted, subject to the conditions mentioned in the application." The General Purposes Committee of the Brighton Town Council have resolved, on an application on behalf of the Brighton and Rottingdean Electric Tramroad Company, that the company shall be released from the requirement that they shall provide sureties to join in the bond for £1,000 to be given by the company for the removal of the poles about to be erected by them for carrying electric cables, and also that security for the removal of the railway in certain contingencies shall not be included in the bond.

Cardiff.—The Lighting Committee have received a letter from Mr. Walter Cook, hon secretary for the coming Cardiff Exhibition, to the effect that the Exhibition Executive Council had decided not to accept the offer of the Lighting Committee for electric light supply, because the total cost would be greater than that of a separate installation. The offer was to supply the exhibition with all the current up to 100 000 units for £1,400. The Chairman said special endeavours had been made to get a supply for the exhibition, and they had made the offer that had been read. But they had to put themselves in the position of guaranteeing the current by the 10th of April. The exhibition would be opened on May 1, but the electric light was wanted before that date, so that the necessary preparations might be made. There were, however, so many extensions and so many orders that he took upon himself to say that owing to the necessities of the ordinary town supply the committee could not guarantee the current by April 10. If there were not the hurry and rush of supplying the exhibition, they would have time to complete the town supply. Major Sloper, Mr. Wentworth Price, and Mr. Williams attended on behalf of the Royal Arcade Company and discussed the question of lighting the arcade by electricity. It was stated that the Arcade Company were prepared to hand over the arcade to be a public thoroughfare on certain conditions, but ultimately the whole question was referred to the Public Works Committee.

Electric Lighting in London.—The Board of Trade have received applications from the Battersea and Newington Vestries asking for provisional orders empowering them to supply electricity within the area of their respective jurisdictions The Board have also received an application from the City of London and Brush Provincial Electric Light Company asking for powers to supply electricity within the district of the St. Saviour's District Board of Works and the parishes of St. Mary (Newington), St. Mary (Lambeth), St. Giles (Camberwell), and St. Mary (Battersea). The time for lodging objections to these applications will expire on January 15, 1896. At a meeting of the City Corporation, Mr. T. H Brooke Hitching asked the chairman of the Commission whether he was aware that the City of London Electric Lighting Company were charging 8d. per Board of Trade unit, while other districts of the Metropolis were supplying light at 6d. ; whether there was any provision made for the purchase of the company's undertaking on an equitable basis, and what notice of purchase was required. Mr H J. Gordon, the chairman of the Commission, said it had granted a concession to the company for public lighting for 21 years, with the option of purchase at the end of seven or fourteen years, the period to date when the contract was completed. As regards private lighting, a similar concession of 21 years had been granted, and the fact was that the Commission had very little control over the company's private lighting.

Hampstead (London) —The Lighting Committee of the Vestry have reported that they had carefully considered the present state and working of the public arc lamps in Finchley-road, and had interviewed Mr. Alexander Siemens on the subject. and were of opinion that a thorough and exhaustive trial should be given to the lamps ; and, further, that, with a view to accomplishing that object, they had asked Messrs. Siemens Bros. to take over the entire charge of the whole of the public arc lamps in Finchley-road for a period of eight weeks and had instructed the engineer to report, on behalf of the Vestry, on the trial at the termination thereof.—Approved. (See "Results of Tenders") The present basis on which meter rents are charged to the private consumers of electric light having been found unsatisfactory, a new scale of charges was decided upon, varying from 2s. 6d. per quarter upwards. It was decided to lay mains for private electric lighting in Lancaster-road and Compayne-gardens. The chief engineer was empowered to obtain materials etc , required immediately, at a cost of £250, and the Lighting Committee were authorised to obtain a further supply, if necessary, before the next Vestry meeting. Mr. Farmer asked a question referring to the proposal to light High-road, Kilburn, by electricity. The Chairman expressed the opinion that it would be very unwise for such a question to be answered whilst the system adopted by the Vestry in the Finchley-road was on trial. The Vestry decided to pay the account of Mr. W. H. Preece, amounting to £150 for preparing plan and detailed estimate of the extension of high and low pressure mains, and arc lighting plant and mains to High road, Kilburn, and West End-lane.

Blackpool.—The *Blackpool Gazette* of December 13 says: "If all we hear be true, Monday's meeting of the Electric Lighting Committee was about the liveliest of all the lively gatherings that have been held from time to time in connection with the Blackpool Town Council. In accordance with the instructions of the committee, Mr. J. Hesketh submitted a report upon the electricity works, in which he recommended that extensions, which would have the effect of doubling the capacity of the works, should be put in hand at once. He pointed out that the works were already overloaded, and he would not be answerable for what might happen unless the plant was increased. In order that any new machinery might be working by Whitsuntide next, it would be necessary to give out orders in the early part of January, and therefore he impressed upon the committee the necessity of urgency. The discussion upon Mr. Hesketh's report was nothing else than a series of scenes. Several members of the Council manifested an astonishing amount of feeling on the question, the Mayor and Councillor Ward being especially antagonistic to the electrical engineer's report. Eventually matters rose to such a pitch that Alderman Bickerstaffe (who was presiding) announced his immediate resignation of the chairmanship of the committee. No decision had been arrived at up to this point, and the meeting forthwith broke up in disorder. We understand that another meeting of the committee is called for this (Friday) afternoon, in order to appoint a chairman. In a matter of so much importance as the future of the electricity works undoubtedly is, we trust that great unanimity will henceforth prevail."

New London Mains.—At Tuesday's meeting of the London County Council the Highways Committee reported that they had (1) considered two notices, dated November 28 and 30, 1895, respectively, from the House-to House Electric Light Supply Company, of intention to lay low-tension mains in (*a*) Earl's Court-square and (*b*) across Earl's Court road They saw no objection to the works proposed. (2) Considered a notice, dated December 3, 1895, from the Westminster Electric Supply Corporation, of intention to lay mains across Rochester-row and Francis-street, and in and across Emery-hill-street. The proposed works were of the usual character. (3) That the Vestry of St Pancras have given three notices, dated November 28, December 3 and 9, 1895, respectively, of intention, under the provisions of the St. Pancras Electric Lighting Order, 1883, to lay mains (*a*) across Pancras-road, (*b*) in Kentish Town-road, and (*c*) in Albert road. The proposed works were unobjectionable (4) They had also considered a notice dated December 5, 1895, from the Charing Cross and Strand Electricity Supply Corporation, of intention to lay mains in and across Whitehall-place. The proposed works were unobjectionable. (5) That a further notice, dated December 6, 1895, had been received from the Charing Cross and Strand Electricity Supply Corporation, of intention to lay mains from the Charing Cross Bridge of the South Eastern Railway Company across and along a part of the Victoria-embankment and along Villiers-street, Duke street, and John-street, across the Strand, and along Bull inn-court to the company's station there. In the opinion of the committee the route proposed is not the best that might have been chosen, and the proposals in the notice are in other respects not quite satisfactory. They have directed the Council's engineer to communicate with the company with a view to the proposal being amended.

Electric Railways in London.—The Vestry of St. Mary Woolnoth have instructed their clerk to take the necessary steps to oppose the new Bill of the electric railway company. The Lord Mayor, as the leading parishioner, will be invited to co-operate with the movement. At the last meeting of the City Commission of Sewers a report was brought up from the Streets Committee relative to the Central London railways and subways, and submitting for approval amended plans of the staircases at the corner of Princes-street (by the Union Bank), Queen Victoria-street (near the Poultry), and by the Mansion House, subject to the works being carried out to the satisfaction of the Commissioners and without prejudice to the rights reserved generally by the Commission in 1893 to alter the position of any staircase or to modify the details in any particular. They recommended that before commencing the works for the purpose of the central station, subways, and approaches, the Central London Railway Company be required to deposit a sum equal to the estimated total cost of the works to ensure their due completion. The effect of the alterations was that there would be separate staircases for the up and down traffic at Princes-street and the Mansion House corners, and that at the Poultry corner the staircase would be partitioned in the middle so that the traffic would be divided. The changes would involve the projection of the present foot pavement at Princes-street by over 6ft., but the refuge in the roadway would be reduced considerably. The roadway itself would still be 26ft wide. Mr. A. J. Hollington said the improvement at the Princes-street corner had only been recently carried out at an enormous cost, and now they proposed to give up 6ft. of the pavement to a railway company. He thought the company should purchase the property, and he moved that the report be referred back for reconsideration. Mr. Ross, the engineer, said the land was estimated at between £30 and £40 per foot. Mr. A. C. Morton said the subways would be of enormous public benefit, and the company were constructing them free of expense. The report was eventually carried.

London County Council.—At Tuesday's meeting the Highways Committee recommended that they be authorised to visit Bristol during the Christmas vacation for the purpose of inspecting the system of electric traction in operation upon the tramways there. They also recommended, "that subject to the condition that at a later stage further plans, giving full particulars of the arrangements for the accommodation of the public, be submitted to the Council, the Council do agree so far only as relates to the positions of the shafts and of the entrance and exits to the plans (submitted by the Central London Railway Company, under the provisions of its Act of 1891) of the proposed stations at Queen's-road, Oxford-circus, and Chancery-lane." The engineers of the company have agreed to the modifications required under the Council's resolution of December 3, in the plans of the stations at Holland-park, Notting Hill-gate, Marble Arch, Tottenham Court road, and Bloomsbury. Further, "that the Parliamentary Committee be requested to approach the Government with a view to the reintroduction, in

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the session of 1896, of the Bill to amend the law with respect to the use of locomotives on highways." Further, "that the Board of Trade be informed that, having regard to the decision upon the appeal with reference to the construction of transformer chambers in St. Luke's and Clerkenwell, the Council is of opinion that no enquiry is necessary in the matter of the appeal of the County of London and Brush Provincial Electric Lighting Company as to transformer-chambers in the Wandsworth district." The Theatres and Music Halls Committee reported that some time ago they instructed the engineer to inspect the electric lighting installations in all the places of public entertainment in London which are licensed by the Lord Chamberlain and the Council. The engineer asks that he may be authorised to employ an additional assistant in order that the work may be carried out as quickly as possible, and as this inspection is in the opinion of the committee urgently necessary in the public interest, they recommended "that the engineer be authorised to employ an assistant at the wages of £4. 4s. per week to assist in getting particulars of and testing the electric lighting installations in places of public entertainment."

Southport.—The minutes of the Electricity Committee of the Corporation contained the following: "Resolved, that is desirable that the following streets should be lighted with electricity—viz., Lord street, from Coronation-walk to Duke-street, and from Seabank-road to Leicester-street, Eastbank-street, Chapel street, London street, and Neville-street." Councillor Hesford moved the adoption of the minutes of the committee. He called attention to the paragraph with reference to the suggested lighting by electricity of Lord-street from Coronation-walk to Duke-street, etc. The committee had been urged by members of the Council and others to light the part of Lord-street from Coronation-walk to Duke-street. He explained that the Electricity Committee could not work on the same lines with reference to lighting the town as the Gas Committee, who could go on with the work of lighting that they considered desirable without approaching the Council. They had not yet been in a position to present to the Council a report of the full year's working of the electric light, but they would do so at the next meeting, and the reason they were approaching the Council at that meeting was because they wished to ascertain whether they were in favour of any further extension whatever of the public lighting by electricity during the next lighting season. It was not the intention of the committee to increase the lighting during the present lighting season. It was merely a preparatory resolution to enable them to furnish themselves with apparatus and appliances to meet the Council's wish should the Council desire any further extension. There were at present 40 lamps; the Halls Committee had now taken two more for the front of the Municipal Buildings, thus making a total of 42 lamps now in operation. Plant had been laid down for supplying electricity to 100 lamps, so there were 58 lamps still undeveloped. Roughly speaking, it would require £1 500 to £2,000 to completely utilise the power of the cables by increasing the number of lamps to 100. The report to be presented at the next Council meeting would include a full return of the borrowing powers, the amount of the capital expended, the revenue and the expenditure. They did not anticipate a loss, and they did not anticipate a profit on the working of the electric light for the year; either way the balance would be represented by about £50. Councillor T. Jones seconded the minutes. Councillor Ashton pointed out that Councillor Travis had not alluded to the dead capital of the Gas Committee. He thought they ought to wait until they knew what the profits of the electricity would be. He should vote for the paragraph being referred back until they had the financial statement before them. The minutes were adopted with the exception of the clause in question.

Electric Tramcars in the Black Country.—The *Midland Counties Express* says: "Once more the question of the continuation of the electric trams in the Wednesbury, Darlaston, Walsall, and Bloxwich districts has arisen. It seems but a few months since the public were wondering whether they would cease to run or not, and now there is the same anxiety and unsettledness. It will be seen from the report of the Walsall Town Council held on Monday afternoon, that a letter was read from the secretary to the Electric Construction Company, Limited, Bushbury, stating that they had given notice to the South Staffordshire Tramway Company that they could not continue to run the electric portion of the tramway company's lines on the present terms beyond the end of the month. It may be stated that the company provide the motive power, the cars and drivers and own the generating station and machinery. The matter is one of great importance, and the travelling public will hope that satisfactory arrangements will be come to before the expiration of the time stated. Whether this will be so or not is at present a subject for speculation. Upon enquiring at the offices of the Electric Construction Company on Tuesday morning, we were informed that there was nothing new to be obtained. The company wish it to be distinctly understood that they have no desire to stop running the electric cars if arrangements can be come to for their continuation, and that it is not they who are putting obstacles in the way. It will be remembered that on the last occasion the Electric Construction Company undertook to run the electric cars at a certain price per mile, the roads to be kept in a satisfactory state by the tramway company. The Construction Company now state that the roads are not in a satisfactory condition; indeed, they are so bad as to cause unnecessary wear and tear to the cars and machinery, thus increasing to the electric company the cost per mile of running the cars. Moreover, they assert that the tramway company for some time have been charged less than was set down in the agreement. They feel that they cannot continue to work the cars as things are at present, hence the month's notice which has been given to the tramway company. We understand that the Construction Company want the roads put in good working order, so that no unnecessary damage shall be done to their cars and machinery, and the rate of payment per mile in accordance to the agreement to which we have alluded. A considerable time would be required to do the necessary repairs to the roads, but the Construction Company are prepared to come to terms for the cars to be kept running, and to make an arrangement for their continuance afterwards. We are assured that unless a satisfactory arrangement be come to at the end of the month, the electric cars will cease to run. The stoppage of the cars will be an enormous public inconvenience, and the public convenience should be first considered."

Edinburgh—It is understood that the Edinburgh Town Council propose to reduce the cost of electricity for lighting purposes from 6d. to 5d. per unit, to take £2 per annum off the cost of each public lamp, and to relieve consumers of the meter rent. Prof. Kennedy, we believe, has made a calculation that during the year from April 1896, to April, 1897 the city will sell about 1,035,000 units to private consumers, and receive at present rates and discounts about £23,000. The number of units mentioned corresponds to about 1,220,000 generated. Besides this the Corporation will have to generate 480,000 units for arc lighting, for which they will receive about £5,000. The total income will thus be £28 000, and the total number of units generated in the station about 1 700,000. Station costs will be about £6,670. The present standing charges amount to £8,500 a year, and, with charges for wages, material, a percentage on additional capital, etc., a total of £18,000 for standing charges is reached. There is thus a gross estimated profit of £8 000, according to Prof. Kennedy, out of which allowance has to be made for depreciation of plant—say, from £1,000 to £2,000. The proposed reduction in price would reduce the income £4 820, against the balance of £8,000, less depreciation. Prof. Kennedy thinks, after a year's working, that the Corporation would be quite safe in making the reduction According to the best tests, it is considered that the price proposed to be charged will be, light for light, equal to the Edinburgh gas. The Plans and Works Committee of the Town Council have recommended, on the motion of Bailie Gulland, that the Tron Church and Register House clocks should be lighted by electricity. The lighting of the City Chambers and the Royal Exchange by electricity was also considered, and a report is to be submitted to the next meeting of the committee by the city superintendent. The Town Council have considered *seriatim* the clauses of the Edinburgh Improvement, Municipal, Police, and Tramways Bill. Clause 27 gives power to the Corporation to use mechanical and electric power on the tramways. Sir James Russell said they would be sure to have the opposition of the telephone companies to the word "electric." The Lord Provost: Why? Sir James Russell: We won't very soon be able to walk the streets for the telephone monopoly. The Lord Provost: We'll have it in. The Council subsequently passed the Electric Lighting Committee's report recommending an extension of plant at the electric lighting station. Sir James Russell remarked that they had every reason to look forward to the future with hope. Before, however, making the reductions suggested by Mr. Mackenzie he should have to make a very careful enquiry into the figures. Treasurer M'Crae complained that the tearing up of the streets had been unsatisfactorily repaired, and Mr. J. C. Dunlop, convener of the Streets and Buildings Committee, also urged that in future extensions due care should be taken to relieve his committee from responsibility for unsatisfactory work, for which the public blamed them. The Lord Provost promised Mr. Dunlop and his colleagues every possible relief in the future.

Swansea.—Members of the Electric Lighting Committee of the Swansea Corporation state that the work preparatory to lighting the central area of the town will be actively proceeded with next month The gas company are experimenting publicly with incandescent gaslights A special meeting of the Swansea County Council was held on Monday for the purpose of considering the questions of electric lighting, electric tramways, and the erection of a dust destructor. The Mayor (Alderman Bradford) presided. The committee presented their report, which stated that detailed plans of the proposed electrical works had been prepared by the consulting engineer (Mr. Manville), and had been forwarded to the Local Government Board, and that the committee had engaged the services of Mr. William John Rees for the acquisition of the necessary land required for this purpose. As regards the question of supplying electrical power for the tramways, the mayor and the town clerk have had several interviews with the directors of the tramways company. Mr. Waller also attended a meeting of the committee on the 11th inst, on behalf of the tramway company and as a result it is now recommended that the price at which the Corporation would be prepared to supply electrical power to the tramways be as follows: (1) the company to undertake to purchase a minimum of 400 000 units per annum at 2d. per unit; (2) if the minimum taken be 600.000 units per annum, the price to be 1½d. per unit; (3) if the minimum taken be 750,000 units per annum, the price to be 1¼d. per unit. The committee recommend that the agreement be approved, and the draft forwarded to the company for their consideration. Mr. George Hopkins, C.E., has been retained to report upon the proposed terms of purchase of the tramways. Mr. Martin, in moving the adoption, said that was the last link in the threefold scheme by which they expected to let Swansea for once stand in the front of other towns of the United Kingdom. One part of the scheme was that adopted some time ago by the Council of destroying its

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refuse by burning it, and thus avoid any possibility of its being a nuisance to any part of the town or district. By destroying the refuse by quick combustion they hoped to be able to save the greater part of the heat generated by that combustion. They hoped to utilise that waste to generate steam, that steam they also proposed utilising to drive machinery, by that machinery generating electricity, and to supply the town with electric light and electric power. They had also come to terms with the Swansea Improvements and Tramway Company for the acquisition of their tramways within the borough limits Those terms were subject to a lease being given to the company for 21 years. At the request of Mr. Daniel, Mr. Martin went on to repeat the details of the terms entered into with the tramway company, which have been already published. If the tramway company took the minimum of 400,000 units, it would come to £3,333. 6s. 8d., which would pay all the cost of their station if they barred the interest on the sinking fund. So far as Swansea was concerned, the threefold scheme would fit in such a way that they would be able to offer electricity at a profit for electric lighting to their ratepayers, business men, and residents at a price which gas could not touch, and that was not so at any other town in the kingdom. Other towns had heard of what Swansea was doing, and had already made haste to follow Swansea's example. No sooner did the chairman of the Electric Lighting Committee at Portsmouth hear of it than he took the matter up, with the result that the authorities of that town are now going in for the same scheme. The report was carried.

PROVISIONAL PATENTS, 1895.

DECEMBER 9.

23564. **Improvements in alloys applicable for solders, electrical safety plugs, fire alarms, heat indicators, and the like.** Alexander Schanschieff, 77, Chancery-lane, London.

DECEMBER 10.

23653. **Improvements in or connected with electric tram or railway systems.** Herbert Allen and Oliver Peard, 55, Chancery-lane, London.

23658. **Switches for underground electric railways.** Alfred Rosenholz and Henry Edward Poehlman, 60, Queen Victoria-street, London. (Complete specification.)

23670. **Improvements in methods of lighting by electric arc lamps.** Paul Henri Guérin, 65, Chancery-lane, London.

23692. **Improvements in electrically-operated apparatus for dental purposes.** Oscar Henry Pieper and Alphonse Ferdinand Pieper, 52, Chancery-lane, London. (Complete specification.)

DECEMBER 12.

23811. **Improvements in or connected with dynamo-electric generators.** Willem de Graaff, 15, Water-street, Liverpool.

23841. **An electrical system and apparatus for synchronously indicating at one or more distant points the distance registered by a ship's log.** Howard George Brain, 1, Furnival-street, Holborn, London.

23844. **Improvements in mooring swivels or apparatus for use in connection with lightships, guardships, or other floating bodies that are connected with the shore by electric or telegraphic cables.** Edward Shore, 6, Lord-street, Liverpool.

23852. **Diaphragms or partitions for electrolytic purposes formed of carbonates of alkaline earths.** Samuel Sidney Bromhead, 97, Newgate-street, London. (La Société Anonyme des Anciennes Salines domaniales de l'Est Actien-Gesellschaft, Germany.) (Complete specification.)

23855. **Improvements in electrical switches.** The Edison and Swan United Electric Light Company, Limited, and Charles Faraday Proctor, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

23857. **New or improved system of telegraphy and telephony.** Richard Joseph Crowley, *Invention* Office, Mitre-court, Fleet-street, London.

23865. **Improvements in or relating to thermo-electric generators.** Alfred Julius Boult, 323, High Holborn, London. (A. Wunderlich, Belgium.) (Complete specification.)

DECEMBER 13.

23892. **Improved means for conveying current to electric motor cars on streets or roadways.** William John McCaw, 62, St. Vincent-street, Glasgow.

23894. **Improvement in telephones and telephone switches or line selectors.** Charles Leigh Clarke and William Paul Theermann, 7, South-parade, Manchester.

23922. **Improved means for compensating variations of load at electrical stations.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.)

23943. **Improvements in the lighting of streets and the like by incandescent electric lamps.** Robert Cornelius Quin and Henry Reason, 31, High Holborn, London.

23952. **Improvements in and relating to electric batteries.** Hartley Fewson, *Invention* Office, Mitre-court, Fleet-street, London.

DECEMBER 14.

23976. **Improvements in ball joint fittings to be used for electric lighting.** Joseph John Perkins Barker and James Stephen Blackwell, 19, Bowling Green-street, Leicester.

23994. **Dynamo machines for producing alternating electric currents of low tension.** Arthur George Adams, 35, Ampthill-street, Bedford.

24020. **Improvements in safety-fuse devices for electrical installations.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

24021. **Improvements in switches for connecting two or more electromotors.** Siemens Bros. and Co., Limited, and Albert Thomas Bartlett, 28, Southampton-buildings, Chancery-lane, London.

24037. **Electric programme or bell-ringing clock.** Leonidas Hamline Watters, 89, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1890.

13260. **Distributing electricity.** Dobrowolsky and another. (Second edition.)

1894.

23099. **Insulators.** Cottis.

25231. **Incandescent electric lamp gauge.** Radcliffe and Philips.

1895.

185. **Telephonic apparatus.** Bassano.

1442. **Electrical ceiling roses.** Clarke and Theermann.

1697. **Arc lamps.** H. and R. Niewerth.

13730. **Primary batteries.** Rowbotham and Levetus.

14158. **Primary batteries.** Rowbotham.

14638. **Electric brakes** Chapman. (Potter.)

14639. **Electric cars.** Chapman. (Potter.)

15371. **Primary batteries.** Rowbotham.

17269. **Galvanic dry cells.** Jungnickel.

17290. **Electric lamp, etc., support.** Davies. (White.)

19317. **Electric railways.** La Burt.

19696. **Electric light display systems.** Woodbridge.

19861. **Electric railways.** Devonshire. (Potter.)

19863. **Alternating-current regulators.** Devonshire. (Steinmetz.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5¾-6¼
Brush Company, Ordinary	3	1¼-1½
—— Non. Cum., 6 per cent. Pref.	2	1¾-2¼
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5¼-5¾
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6¾-7¼
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	12¾-13¼
—— 6 per cent. Cumulative Pref.	10	15¼-16
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	130-132
—— 5 per cent. Pref. Shares	10	14¾-15¼
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	6	8¾-9
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	¾-1
—— 7 per cent. Cumulative Pref.	2	2-2½
Elmore's Copper Depositing	2	1-1¼
Elmore's Wire Company	2	¾-1
Fowler-Waring Cables	5	1¼-1½
W. T. Henley's Telegraph Works, Ordinary	10	13¾-14¼
—— 7 per cent. Preference	10	15¾-16¼
—— 4½ per cent. Debentures	100	108-111
House-to-House Company, Ordinary	5	4¼-4¾
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	18-19
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge Ordinary	5	7¾-8¼
—— 6 per cent. Pref.	5	7-7½
Liverpool Electric Supply, Ordinary	5	7¾-8¼
Liverpool Overhead Railway	10	11¾-12
—— 5 per cent. Pref.	10	15¾-15¾
—— 4 per cent. Mortgage Debentures of £100	100	114-116
London Electric Supply	5	¾-1
Metropolitan Electric Supply	10	10¾-11¼
—— 4½ per cent. First Mortgage Debenture Stock	100	117-120
National Telephone, Ordinary	5	5¾-6¼
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15¾-16¼
—— 5 per cent. Non. Cum. Third Pref.	5	6¼-6¾
—— 3½ per cent. Deb. Stock	100	106-108
Notting Hill Company	10	8¾-9
Oriental, Limited, £1 shares	1	1-1¼
—— £5 Shares	5	7¾-8¼
—— £4½ shares	4½	6¼-6¾
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-106
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8¼-8¾
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	39-41
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4¾-5
Westminster Electric Supply, Ordinary	5	8¼-8¾
Yorkshire House-to-House	5	6¾-7¼

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NOTES.

The Queen and the Electric Light.—A short time ago we printed a note headed "The Queen *v.* the Electric Light." Her Gracious Majesty was reported to be as much opposed to "the" illuminant as the Empress of Austria or Harry Furniss is. We are glad to be now able to substitute the conjunction for the preposition. Balmoral Castle is to be lighted by electricity, according to a Scotch newspaper. The motive power is to be taken, not from the Dee, but from the Gelder. In the first instance the electric light will be fitted up in the ballroom only, but ultimately, no doubt, all the rooms of the Castle will be supplied with the current. It is stated that the expenditure contemplated is about £1,400.

Light Railways.—Mr. Ritchie, P.M., President of the Board of Trade, has written to Mr. Wallis Davies, the secretary of the Light Railways Association of Great Britain, stating that he will be happy to receive a deputation on behalf of the association on Thursday, February 13, at noon. The committee appointed will sit during the month of January, and consists of the Duke of Sutherland, Lord Winchilsea, Lord Clinton, Lord Sherbourne, Earl Russell, the Earl of Warwick, Sir Albert K. Rollit, M.P., Sir Alfred Hickman, M.P., Sir John T. Hibbert, Sir John Puleston, Sir Douglas Fox, Sir James Szlumper, the Hon. C. H. Strutt, M.P., and other members of Parliament representing various parts of the country, as well as representatives of local authorities throughout Great Britain.

Aluminium.—From *Comptes Rendus* (December 2) it appears that M. Henri Moissan has been investigating the contradictory results which experimenters have arrived at with reference to some of the properties of aluminium. M. Moissan ascribes these to the fact that all commercial samples of this metal contain impurities. The effects of nitrogen and carbon he has already dealt with, and having had occasion to analyse samples of aluminium from the works at La Praz (France), Neuhausen (Switzerland), and Pittsburg (United States), he has now discovered a new impurity—namely, sodium. This may be present to the extent of from ·1 to ·3 per cent., and renders the aluminium liable to be slowly attacked by water. The presence of a small quantity of sodium also completely alters the character of aluminium alloys.

Responsibility for Electric Death.—A short time ago two persons were unfortunately killed by coming in contact with a wire belonging to the Elektrizitäts-Gesellschaft in Limburg (Lahn) which had become detached from its place in a storm. The manager of the company was eventually put upon his trial for manslaughter, negligence being alleged against him. He has, however, now been acquitted. He affirmed himself, and was supported by two experts in his opinion, that it had not hitherto been known that a current of under 1,000 volts could kill a man; and the judges were not in a position to refute this argument. It was shown that the pressure of the current on the day in question did not exceed 800 volts. The said judges would doubtless find the recent Board of Trade discussion on high pressures interesting reading.

Foreign Royalty at the Arsenal.—Prince Nicholas of Greece paid a visit to the Royal Arsenal, Woolwich, the other day, and was received at the office of the Director-General of Ordnance Factories by Dr. Anderson and the heads of departments. Prince Nicholas proceeded on the Arsenal railway to the proof butts, where he witnessed the firing of heavy guns, both with cordite and black powder. He then visited the torpedo factory, where the various operations of manufacturing Whitehead torpedoes were shown, after which he saw the filling of small-arm cartridges and the manufacture of cartridge cases. At the South Boring Mill he witnessed the operations of winding wire of guns, the turning and boring of large forgings, and the working of the 40-ton hammer. In the Royal Carriage Department he saw the new 9·2in. gun mountings, worked by electricity, for the new cruisers "Powerful" and "Terrible."

The Metric System.—A deputation of six members of the British Chamber of Commerce in Paris, accompanied by representatives of several important English newspapers, were present the other morning in Paris at two successive lectures on the metric system. Both lectures were original and were delivered by children under 12 years of age, one in a boys' school and the other in a girls' school. Mr. Pilter, speaking on behalf of the British Chamber of Commerce, thanked the municipality of Paris for having once more given an opportunity for the appreciation of the admirable simplicity of the French metric system. He added: "I hope and I am sure that the British representatives who have heard these lectures will give an account of these meetings, and I am convinced that the account which they will give of them will advance the adoption of the metric system in our country. We hope that, in view of all the facilities which it offers, our country will soon be endowed with the metric system, which the whole world owes to the French nation, and for which it must feel eternally grateful to her."

Gas v. Electric Light.—In continuation of this subject (see p. 699) a correspondent would like us to have his opinion of the incandescent gaslight. We are always willing to open our columns to the ventilation of grievances in which our readers are professionally interested, so we readily give space to this correspondent's wail of complaint. He says: "I had two of these incandescent gas lamps fixed in a sitting-room at the beginning of the year, with the intention, if I liked them, of having them fitted all over my house. I was immensely pleased with the light they gave, but my pleasure was soon turned to dismay when I noticed that a most offensive smell was given off from them when they were turned down to the by-pass. The workman who fitted the lamps from the local representative of the company came repeatedly to endeavour to remedy this defect, but without success. The smell was so offensive that I was compelled to discontinue using the by-pass and to turn the light off every time it was done with. This of course necessitated relighting the burner each time it was required, and, as those using the lamps must be aware, the lighting of them is rather an awkward matter, especially for servants, as the burner lights with an explosion, and this in course of time shatters the mantles." And everyone knows what "shattering the mantle" means to the poor gas consumer.

Personal.—Dr. R. Mullineux Walmsley, lately professor of physics and electrical engineering in the Heriot-Watt College, Edinburgh, and recently appointed principal of the Northampton Institute, London, was, on Friday, the 20th inst., made the recipient of a handsome gift of books from his past and present students of the college. The presentation, which consisted of an edition of Scott's works and Ruskin's "Stones of Venice," was made by Mr. C. A. Henderson, one of the day students. Principal Ogilvie, who presided, remarked that they met under very mixed feelings. They felt very sorry at parting with Dr. Walmsley, but warmly congratulated him upon his new appointment. Many of them had had an acquaintance with him extending over a period of six years, and during that time the progress of the college had steadily extended. When Dr. Walmsley came the institution was at a stage when a strong mind and a master hand were required, and

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the governors were to be congratulated upon their selection of Dr. Walmsley, because in his hands the department over which he presided had been successfully carried on. The staff were fortunate, because as a fellow-worker he was capable and willing to assist in all the general work of the college, and thus lightened the work of all. The students were also fortunate in having Dr. Walmsley, because he had had the laboratory so well equipped for all those who belonged to the various paths of service in which electricity and physics generally formed an essential feature.

East London Trades, Industries, and Arts Exhibition.—We have received a prospectus and schedule of prizes of an exhibition which is to be held next June at the People's Palace under the honorary presidency of H.R.H. the Prince of Wales, and in which electricity will play a more or less important part. There is a very influential list of vice-presidents, a thoroughly businesslike executive committee, and a very extended general committee of sympathisers. The salient features of the exhibition, in addition to the usual industrial exhibits that may be expected from manufacturing firms, are: (1) a special section for the work of individual craftsmen; (2) a section for the work of apprentices and of students at the various London polytechnics (the most important of these institutions all over London are expected to take part in the exhibition); (3) a women's section. Provision will be made for a continuous series of concerts and other entertainments during the exhibition. Mr. Edmund H. Lloyd, of the Military, Naval, and Chicago Exhibitions, has been engaged as manager of the exhibition. The committee desire to get together a guarantee fund of from £8,000 to £10,000, and their exertions during the last eight months have already brought them in more than £6,000. They have also received donations towards the objects of the exhibition to the amount of £1,000. They hope that by bringing the matter forward publicly the objects of the exhibition will become known to those to whom it is intended to benefit, and that the remaining £2,000 or £3,000 will soon be collected, either in the form of guarantees or subscriptions.

Alternate-Current Transformers.—The following is a synopsis of the Society of Arts Cantor lectures on "Alternate-Current Transformers," which are to be delivered by Dr. J. A. Fleming, F.R.S.: January 20—Lecture I.—The Action of the Transformer: Real and imaginary transformers—Transformer diagrams—Alternate-current curve tracing—Various forms of curve tracers—Discussion of transformer diagrams—The harmonic analysis of diagrams—The curves of induction and hysteresis—Magnetic leakage—Core and copper losses—Effect of variation of form of the E.M.F. curve on core losses—Variation of core losses with temperature—The power factor. January 27—Lecture II—The Construction of the Transformer: The core—Sheet-iron stampings—Building the core—Prevention of core losses—Selection of iron—The coils—Coil winding—Insulation of coils and core—The case—Ventilation and surface radiation—The terminals—Primary and secondary fuses and switches—Sizes and forms of transformers in practice—Open and closed circuit transformers. February 3.—Lecture III.—The Testing of Transformers: The measurement of the power taken up in an inductive circuit—The theory of the wattmeter—The construction and use of the alternate-current wattmeter—Various methods of measuring alternating-current power—The testing of transformers—Testing by curve tracing—Testing by the wattmeter—Differential testing—Practical tests in the sub-station and workshop efficiency curves—Core losses for various sized transformers—Specifications for transformers—Measurement of copper losses and drop—Iron testing. February 10.—Lecture IV.—The Employment of the Transformer: Defects in transformers—Causes of failures—Current rushes into transformers—Variation of core losses, with time and temperature—House transformers—Sub-station transformers—Two and three phase transformers—Transformer distribution—Importance of large power factor—Influence of load factor on annual losses—Capacity—Effects in case of large transformer systems—Designs for alternating-current stations—Conclusion.

"Superseding Electricity."—The latest claimant for journalistic electrical honours in America—the *Electrical Journal* of Chicago—has a formidable editorial staff, comprising, as it does, in addition to the managing editor (Mr. Hornsby), the following gentlemen: Henry S. Carhart, LL.D., Fellow Amer. Assoc. for the Advancement of Science, Foreign Member of the Institution of Electrical Engineers (London), Professor of Physics and Electrical Engineering, University of Michigan, etc.; William A. Anthony, Ph.B., M.A.I.E.E., Fellow of Amer. Assoc. for the Advancement of Science, etc.; Benjamin F. Thomas, Ph.D., Fellow Amer. Assoc. for the Advancement of Science, M.A.I.E.E., Professor of Physics, Ohio State University; William J. Herdman, Ph.B., M.D., ex-president of the American Electro-Therapeutic Association, Professor of Diseases of the Nervous System and Electro-Therapeutics, University of Michigan; Dugald C. Jackson, C.E., Member American Society of Mechanical Engineers, M.A.I.E.E., Professor of Electrical Engineering, University of Wisconsin. Yet, under the heading of this note, we find in a recent issue, without comment of any kind, the annexed paragraph anent what a humourist a long time ago termed "the Keely-Cranky motor": "It is said that John Jacob Astor has acquired the interest of Mrs. Bloomfield Moore in the Keely Motor Company, and will give it financial backing. Mr. Keely has promised the directors of his company that he will be through with his experiments by January 1 next, and that he will then put to a practical and successful test the results of his 20 years' labours. An expert who has investigated Mr. Keely's new force is reported to have said that 'There is no use in our devoting any more time to electricity. This is something far better. When Keely has constructed his railway traction engine, possessing rights over all the world, and using a costless force, and when a patent has been taken out on it the value of the discovery will be found to be incalculable. One of the directors of the company who recently talked with Keely is credited with the statement that the most wonderful use to be made of the new force is in the push-engine, or machine intended to propel street cars or vehicles of any kind on land or in the water. This is described as being a cylinder, 18in. by 8in. approximately, boxed up in portable form. This box is to be fastened to the front platform of the vehicle, and without any gearing or wire connection, or connection of any kind between the box and the wheels, the energy generated in the box is to turn the wheels and push the vehicle along. Some time next year it is expected that people will be able to get light, heat, and power for motor purposes in their homes and factories at trifling cost.'"

The French Method of Treatment for Electric Shock.—The prominent points of the circular which the Minister of Public Works in France has issued to the prefects throughout the republic on the measures to be taken in the event of an apparently fatal contact with live electric wires are the following: "The medical treatment of cases of shock is the same in all instances; but the steps to be taken for the preservation of the patient, or the safety of the helpers, are different according to whether the current

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is a continuous or an alternating or commutated alternating one. According to the Academy of Medicine, the victim, even though apparently dead, must be at once taken, if no longer in contact with the electric wires, to a well-aired place, the number of persons in which is strictly limited to those whose services are necessary. The clothes are to be loosened (trousers and open shirt) and as promptly as possible you try to re-establish the respiration (as in the case of persons apparently drowned) by rhythmically pulling the tongue or by artificial respiration, and the circulation by rubbing the surface of the body, by whipping the trunk with the hands or with wet napkins, throwing cold water on the body from time to time, and by bringing ammonia or vinegar to the nose. The method for tongue-pulling is to open the mouth, using force by any convenient means, if necessary, as by the handle of a knife or a piece of wood; to grasp the tongue solidly, preferably with the aid of a pocket-handkerchief to prevent slipping; to pull the tongue forward, firmly and rhythmically, letting it slacken after each pull, about 20 times a minute; and keep this up for half-an-hour, an hour, or more. The method for artificial respiration is to lay the victim on his back, shoulders slightly raised, mouth open, tongue free; grasp the arms at the elbows, squeeze them firmly against the chest, then separate them, and bring them above the head, describing an arc of a circle, then bring them back to their former position at the sides of the chest. Repeat this about 20 times a minute, and keep it up until natural respiration is restored. It is better to begin in every case with the tongue-pulling, and, if possible, to carry on the artificial respiration at the same time. If the victim is still in contact with the wires the salvor must, before acting as directed, get him away from these. But in order to do that he must himself take certain precautions. For example, he must avoid touching him with the bare hands, and must wear thick gloves of dry stuff—linen or flannel of sufficient thickness; and he must not lay hold of the person injured by any wet or moist part of his body, as by his feet or under his arms. It may be necessary to cut the wires in order to free the body. But this is entirely inadmissible in the case of continuous currents, on account of the risk to the cutter occasioned by the spark or extra current on breaking circuit. It is not so with alternating or commutated alternating currents. In that case the wire may be cut without danger; but it is necessary to cut the wire on both sides of the victim in order to be sure that the cutting is really of use.

Behaviour of the Carbon Brush on Power Generators.—The *Electrical World* reproduces from the *Sibley Journal* for October a short article by Prof. Ryan, in which he gives an explanation of the action of the carbon brush on power generators. In dynamos for incandescent lighting the self-induction of the armature coils is small, the air gaps are large, and the E.M.F. of the field is easily maintained greater than the maximum of the armature; and under these circumstances it was easy to maintain suitable conditions for the successful commutation of the currents by means of metallic brushes; furthermore, the load fluctuates slowly. But when power generators came into use it was found that such a method of current commutation was utterly unsuited, and it was then that Vanderpole suggested the use of carbon brushes, which were found to be a great success; he thinks that a far greater part of the success of the electric street railway than people have thought has been due to the use of carbon brushes on the generators and motors: the load changes so suddenly that no adjustment is possible, and it is therefore of interest to see in what way the brushes take off the current, making their movement unnecessary, to avoid sparking. The self-induction E.M.F. formed by the sudden reversal of the current in such coils is high, and some sort of E.M.F. must be available to oppose this with a balance sufficient to reverse the current against the ohmic resistance; there is no aid of the E.M.F. generated in the fringe of the leading pole tips. Supposing that the brush completely covers one commutator bar and partially covers the two neighbouring ones, the restraint area of contact of one of the latter presents considerable resistance to the passage of the total current from one side of the armature, and this gives rise to a considerable local fall of potential, which diverts a considerable portion of the current through one of the two coils which are short-circuited, and as the entire surface of the bar connected to the other end of that coil is under the brushes, there is therefore less constant resistance. To explain the tendency to reverse the current he applies a similar argument; there is a restricted area of contact constantly diminishing with increasing resistance, so that just before a bar comes completely under the brush a high local fall of potential occurs, which causes some of the total armature voltage to divert the current by way of the neighbouring coil against the current already in that coil, causing it to reverse quickly in opposition to the E.M.F. of self-induction. In this way the high specific resistance of carbon is used advantageously for effecting commutation without the aid of the pole fringe E.M.F.; it cannot be depended upon for complete commutation, but in most generators with armatures of the iron-clad type fully half of the current may be thus commutated. In street railway generators it is usual to adjust the brush at no load, so that it is in the neighbourhood of the magnetic fringe of the leading pole tip, where the E.M.F.'s mechanically generated are sufficient to reverse one-half of the normal current. These E.M.F.'s are not sufficient to cause serious short-circuiting of the coils under commutation under no load and assist the carbon brushes. It is in this way that generators are now made sparkless under the most trying conditions.

The Comparative Cost of Gas and Electricity.—In the report which has been drawn up by Mr. A. P. Trotter, B.A., A.M.I.C.E., on behalf of the Hastings and St. Leonards Electric Light Company, a comparison is made as to the cost of lighting by gas and by electricity, the figures given being based on a series of photometric tests. The lamps used in the electrical tests consisted of three Edison-Swan 16-c.p. 100 volt lamps, which had been in use for some weeks previously; three "Gabriel" 16-c.p. 100 volt lamps, which were new; and one Edison-Swan "Sunlight" 100-c.p. 100-volt lamp. The comparison was made under fairer conditions than are usual in such tests, as good ordinary burners were used, in place of the Argand, so dear to the heart of the gas engineer when engaged in endeavouring to prove the superior economy of his product. These burners consisted of a "Christiania" burner tested with and without its opal globe, three steatite "Union" burners of the Bray type, two of which were marked No. 5 and the other No. 6, and one slit batswing burner. The results of the tests were as follow:

Lamps.	Volts.	Amperes.	Watts.	Total candles.	Candles.	Watts per candle.
E.S. 16	103	1·82	187·0	61·0	20·3	3·2
E.S. 100	102	2·46	251·0	—	103·0	2·43
Gabriel.	102	1·7	173·4	52·5	17·0	3·03

Burner.	Pressure.	Cubic feet per hour.	Total candle-power.	Candles.	C.P. pr. c. ft. pr. hr.
Christiania	34½	6·2	—	13·4	2·16
Ditto (with globe)	34½	6·2	—	7·9	1·27
Bray	24	34·0	39	13·0	1·15
Batswing	3	16·0	—	38·0	2·38

Mr. Trotter continues in his report: "It is perhaps some-

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what beyond my province here to call your attention to the fact that the comparative cost of lighting by electric light and by gas must be considered on a wider basis than that of light for light. The saving in the cost of redecoration is very material, and the absence of injury to delicate goods in shops by the products of combustion and vapour of gas is of no little importance. Besides this, the wholesomeness of electric light for domestic lighting, though it cannot be set down in shillings and pence, is none the less valuable. Especially should this be considered in Hastings, where the very high pressure of the gas doubtless forces much unconsumed gas into the air. I assume that the price of electric supply varies from 4d. to 8d., and that incandescent lamps take a mean of three watts per candle, and that gas-burners yield two candles per cubic foot. The equivalent price of gas is :

Price per unit.	Price per 1,000 cubic feet.
4d.	2s. 4d.
6d.	3s. 4d.
8d.	4s. 4d.

Next, I assume that the price of electric supply is kept constant at 6d. per unit, and the efficiency of the lamps is altered. I desire to call your attention to the fact that the effect on the equivalent price of gas is no less marked, and that a knowledge of the efficiency of lamps, which can only be arrived at by careful photometric tests, is as important as a knowledge of the price of electric supply per unit. I have roughly estimated the alteration in life of incandescent lamps when run at a higher pressure, from the results of various life tests :

Mean watts per candle-power.	Renewals per 1,000 c.p.-hours.	Price of gas.
4	1d.	4s. 2d.
3	2d.	3s. 4d.
2½	4d.	3s. 2d."

Proceeding to consider the relative cost of arcs and Welsbachs, he says : "No strict comparison is possible, because the contract for arc lighting includes, I understand, the supply of carbons, trimming, cleaning, all repairs and maintenance of lamps and lanterns, and interest on capital outlay. I have no figures before me as to probable cost of lamp-lighting and cleaning, damage to mantles by gales and sea-water, general repairs and maintenance, nor have I any information as to the possibility of using incandescent gaslights in so exposed a position as that of your arc lamps. . . . . It may be assumed that for 1·11d. worth of gas the total may be put at 1·43d. for a naked light of 500 c.p. for one hour, exclusive of cost of lamplighters, cleaners, damage by wind and water, repairs, and interest on capital outlay. I understand that each arc lamp takes 15 apparent amperes at 50 apparent volts, or 600 true watts, and that for a service of 160,000 lamp-hours per annum, including supply of carbons, trimming, cleaning, repairs to 52 lamps and lanterns, and interest on capital outlay of lamps, post transformers, and mains, the sum of £1,300 is paid. This comes to 3¼d. per unit, or 1·95d. for a light, reduced and diffused by corrugated glass, of a mean of about 500 c.p. for one hour." In conclusion, Mr. Trotter observes that it is clear that the difference of 0·52d. would not cover the incidental expenses, and that, if the two systems of lighting were placed on equal conditions, the cost of gas lighting would largely exceed that of the contract for electric light. By the way, a dinner is to be given to Mr. Trotter at the Whitehall Club prior to his departure to take up his duties under the South African Government.

Direct v. Alternating Currents for Long-Distance Transmission.—Mr. Wm. Baxter, jun., discusses this subject in the New York *Electrical Engineer* of December 4. He says that there is a fascination about alternating-current problems that no doubt has had a great deal to do with making the system a favourite with the foremost electrical engineers. Most of these problems are so abstruse as to be beyond the comprehension of the average electrician ; therefore those who are gifted with a mind able to grasp the subject enjoy a certain amount of exclusiveness not obtainable in the simpler and more commonplace direct-current field. To determine the merits of the system for long-distance work, the best way is to analyse what has been done in that line. The most important work up to date has been the Niagara installation. According to the published descriptions of this plant, the main generators develop an E.M.F. of 2,250 volts. As this E.M.F. is too low for the increased transmission of current over any considerable distance, step-up transformers will be used to develop a current of higher E.M.F. to send over the line. At the receiving end a step-down transformer will induce a tertiary current of whatever E.M.F. the conditions may require. Inasmuch as, in the present state of the art, alternating currents can only be used successfully for incandescent lighting, and with partial success for arc lighting, it follows that for all other purposes a direct current derived from a rotary transformer will be required. Dealing with a direct-current system, in making the comparison Mr. Baxter assumes that the same E.M.F. is used. The method of transmission would be as follows : the generators would deliver a current of sufficiently high E.M.F. to pass direct to the line without any intervening transformation. At the point of distribution this current would operate rotary transformers that would generate a current of the E.M.F. required for distribution. It will at once be seen, the author remarks, that such a system would be more efficient than the alternating, because there would be only four sources of loss—namely, the generator, the line to point of distribution, the rotary transformer, and the local distributing mains. The average efficiency of the generators can be taken at 90 per cent., the same as that of the alternators. The line loss would be less with the same size conductors, but as the frequency in the alternating system here considered is only 25, the difference in the line efficiency would be less than ½ per cent. in favour of the direct current. He, therefore, takes the average line loss at 6 per cent., the same as for the alternating system. The rotary transformer could be made to give an efficiency of 85 per cent., but the present calculation will be based on 80 per cent. With these efficiencies the energy delivered to consumers would be about 64 per cent. of that applied to the generator shaft, against 54 per cent. for the alternating system. From the foregoing it will be seen that so far as efficiency is concerned the direct-current system is considerably ahead of the alternating ; but it may be contended that there are difficulties in the way that would make it, perhaps, impossible to obtain in practice the results above given. If, Mr. Baxter says, we could do away with the step-up and step-down transformers, the efficiency of the alternating system would be largely increased. Under such conditions it could more than hold its own with the direct current ; but whatever may be possible with respect to the step-up transformer, it certainly would not be prudent to drop the step-down transformer, and send the high-potential primary direct to the premises of consumers. Discarding the step-up transformer would not render the system as efficient as the direct, because the loss in the step-down and small transformers would be greater than that in the rotary transformer of the direct-current system. It is hardly worth the trouble, however, as the author remarks, to consider what the efficiency would be if the system of alternating-current transmission were different from what it is. We must consider the subject as it stands.

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CITY AND GUILDS OF LONDON INSTITUTE.

LECTURE XX.

(Specially Contributed.)

Mirrors and Reading Apparatus.—Prof. Chrystal says: "The glass of the mirror should be very thin, otherwise a greater or less correction for its thickness will be necessary. In the *subjective* method of reading, a scale is fixed before the mirror, which is usually plane (it must be well made to be of any use), and the image of the scale is observed by means of a telescope fixed over or under the scale,

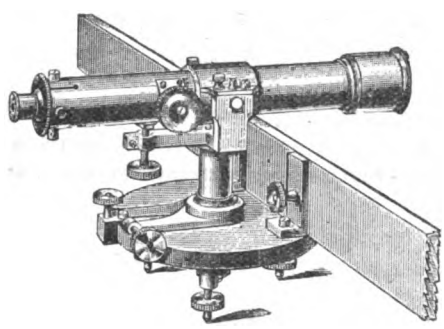

FIG. 1.

Fig. 1. The scale divisions are seen to pass the wires of the telescope, and if a circular scale be used whose centre is in the axis of suspension of the mirror, the difference between the numbers on the cross-wires in any two positions of the magnet is a measure of twice the deflection of the magnet. A correction is necessary when a straight scale is used. In the *objective* method, which is more usually used in this country, the mirror is concave, and reflects the image of a fixed illuminated slit (often furnished with a vertical wire where greater accuracy is required) upon a graduated scale. The readings are proportional to double the deflection of the needle, or to the tangent of the double deflection, according as the scale is circular or straight." The best form of scale probably to use is the transparent scale first introduced by Mr. F. Jacob.

Kelvin's Mirror Galvanometers.—Fig. 2 shows one form out of many in which this instrument is constructed. It is an astatic galvanometer. In it we have two systems

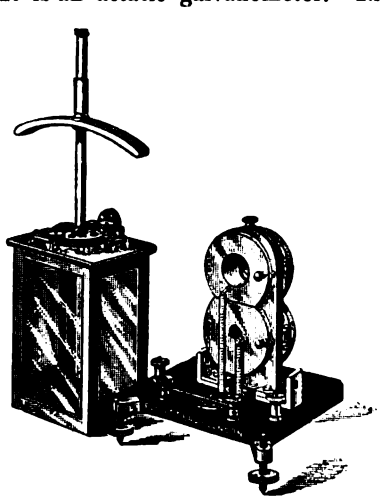

FIG. 2.

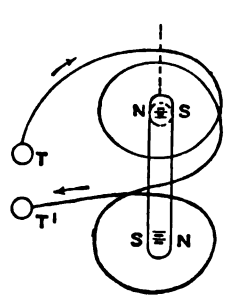

FIG. 3.

of magnets carried by a very light strip of mica, one system of magnets—the upper in this case—carrying also a very light concave mirror. In the diagram (Fig. 3) T T^1 represent the terminals of the coils. The direction of the current in the coils is shown by the arrows. The tendency of the current is to turn each needle in the same direction, as will at once be seen by referring to Ampère's rule. Each coil is really made up of two coils, which can be easily taken apart to allow of the putting in of the magnet system or of its examination. The magnet suspension is by means of a quartz fibre or of unspun silk, and is such that the system can be slightly raised or lowered without putting any torsion on the suspension. The coils are surrounded by a glass case carrying a controlling magnet. This controlling magnet allows the sensitiveness of the instrument to be increased or decreased within certain limits. First, however, if the astatic system be imperfect, the controlling magnet can be so placed that it keeps the spot of light at zero when no current is passing. If it is desirable to have the system controlled by a weak magnetic field, the controlling magnet—which is, of course, a permanent magnet—is raised on the vertical rod as high as it will go. If we want a stronger field, we lower the permanent magnet on the rod. These instruments are usually placed upon an ebonite base to secure good insulation, carried by three levelling screws, and the apparatus must be carefully levelled before use. Duplicate sets of coils are frequently supplied with these instruments. Thus one set of coils may have as small a resistance as half an ohm, and the instrument can be used with large currents, while another set may have a resistance of 10,000 ohms, to be used with small currents. Instruments of this kind have been made with coils of over 350,000 ohms resistance.

Shunts.—Frequently we have to deal with currents that would injure these delicate galvanometers, and to guard against such injury, and to increase the range of the instrument, we add another path for the current parallel to the galvanometer, and this we call a shunt.

There is only one way to reduce the current through a galvanometer, and that is by the reduction of the acting pressure across its terminals. The shunting of a galvanometer thus always means the reduction of the pressure acting across its terminals.

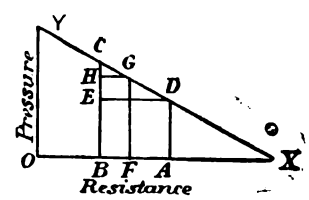

FIG. 4.

In Fig. 4 let O Y represent total pressure of circuit;
let O X represent total resistance of circuit;
let A B represent resistance between terminals of galvanometer.

From A and B draw A D, B C parallel to O Y.

From D draw D E parallel to O X.

Then E C will represent that part of the total pressure which is used in overcoming the resistance A B.

If, now, the galvanometer is shunted, the resistance between its terminals is lessened—it is, in fact, the joint resistance of shunt and galvanometer.

Let this resistance be represented by B F.

Through F draw F G parallel to O Y.

Through G draw G H parallel to O X.

Then H C will represent the pressure used to overcome the resistance of the shunted galvanometer, and the current through galvanometer will be that due of pressure represented by H C.

The insertion of the shunt has also decreased the resistance, O X, but to keep the resistance, O X, constant, and hence the current of the circuit constant, a resistance = F A is inserted as a compensating resistance.

Usually three shunts are made for every galvanometer, so that in one case $\frac{1}{10}$th of the current goes through the galvanometer and $\frac{9}{10}$ths through the shunt. In the second case the currents are respectively $\frac{1}{100}$th and $\frac{99}{100}$ths, and in the third case $\frac{1}{1000}$ths and $\frac{999}{1000}$ths.

Let us consider that in any circuit the current is found by the use of the formula,

$$C = \frac{E}{R}.$$

Now, if we decrease R to R_1, with E constant, we increase current from C to C_1.

By the introduction of a shunt across the terminals of the galvanometer we do decrease the total resistance of the circuit, and E remaining constant the current is increased. As a rule we do not want to measure the new current,

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but the old, and to do this we must restore the original resistance of the circuit.

Thus, roughly speaking, if we shunt a galvanometer we alter the conditions, which we more or less restore by the adding of a compensating resistance to the circuit.

Assume this all done and that the current in the new circuit is the same as the current in the old.

Now, the number of amperes per second passing through any one section of the circuit is the same as for any other section of the circuit. Let Fig. 5 represent the circuit

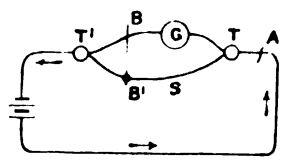

FIG. 5.

with galvanometer and shunt. Imagine sections of conductors at A and B. The current passing through section A will pass through any section, as at B B_1. No more and no fewer amperes will pass B B_1 per second than pass A. In fact, we may look upon the two sections B B_1 as forming one section of a thicker wire, and all that would take place in a circuit wherein the conductor varied in area would be that the density of current flow at the smallest section would be greater than at the larger section.

Let C = current.

C at T divides between T G T_1 and T S T_1 inversely as their resistances.

If the resistance T G T_1 is nine times that of T S T_1, then one part of C will go by T G T_1 and nine parts by T S T_1.

We can arrange the shunt resistance so that any portion we desire of the current shall go by it.

Thus if $\frac{1}{10}$th of current is to go through galvanometer, we must have a shunt that is $\frac{1}{9}$th of the resistance of the galvanometer.

To find the resistance of a shunt so that n times the current going through the galvanometer goes through the shunt, we simply divide G, the resistance of the galvanometer, by n; thus $\frac{G}{n} = S$, the resistance of the shunt.

A galvanometer has a resistance of 9,000 ohms. What is the resistance of a shunt that takes $\frac{9}{10}$ths of the current?

Here the shunt current is nine times greater than the galvanometer current, so the resistance of the shunt must be $\frac{1}{9}$th that of the galvanometer—

$$\frac{9000}{9} = 1{,}000;$$

that is, the shunt will have 1,000 ohms resistance. If nine parts of the current go through the shunt and one part through the galvanometer, then the total current is 9 + 1, or 10. Thus, if $\frac{1}{n}$th part of the current is to go through the galvanometer, the resistance of the shunt $\frac{1}{n-1}$th part the resistance of the galvanometer.

Suppose we want to find the total current—that is, the current flow through any other unshunted section of circuit. We use a multiplier, called the multiplying power of the shunt, and this is merely the sum of the ratios of the resistance of the galvanometer and shunt. In the above case the ratios are

9 : 1 and 9 + 1 = 10, which is the multiplier wanted.

We know the current, C, going through the galvanometer, then $10 \times C$ = total current.

If the ratios were 6 : 1 then 6 + 1 = 7 would be the multiplier.

" " 99 : 1 " 99 + 1 = 100 " " "

or,
$$\frac{\text{R of galvanometer} + \text{R of shunt}}{\text{R of shunt}} = \text{multiplying power of shunt.}$$

Differential Galvanometer.—This is a galvanometer in which the needle is acted upon by two equal coils wound so as to oppose each other. When equal currents go through the coils the needle remains at zero.

Ampere-Meters.—For short, these instruments are generally called ammeters. The delicate instruments hitherto mentioned are not suited for measuring large currents. The ordinary current used in an electric light station would most probably fuse the wire of the coils and destroy the instrument. Hence, with the introduction of the use of larger currents, different instruments were devised. M. Deprez was perhaps the first to devise such an instrument, modifications of which are now to be found in every light and power station.

The principles upon which these instruments are based are very simple. In the first place, it is very desirable to do away with all arithmetical calculations, and to make an instrument which shall read directly in amperes. The divisions of the scale of the instrument used then indicate amperes, and if the pointer point to the division marked "20," or to that marked "30" or "300," we read 20, 30, or 300 amperes, as the case may be, without troublesome calculations about tangents.

An instrument of this kind is simply constructed. Let N S (Fig. 6) represent a strong permanent magnet. If, now, a

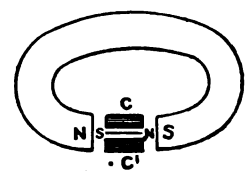

FIG. 6.

small needle, n s, be suspended between the poles, N S, its position at rest may be said to be controlled by the magnet, and the position of the small magnet or the light pointer carried by it may be marked on a scale as the zero position. Let the coils, C C_1, have the current to be measured passed through them. The effect of the current field will be to deflect s n from its zero point. If, now, we make a scale showing by means of a pointer the zero position—that is, the position of s n when no current goes through the coil—and the position when one, two, three, four, etc., amperes go through the coil, we shall have an instrument whose readings show amperes. The current going through the coils may be measured by means of a standard instrument. Various ways have been used to hold the needle in the zero position. As we have seen, it can be done by the aid of a permanent magnet; it can also be done with the aid of an electro-magnet, by means of a spring or by the action of gravity. Thus we get permanent-magnet, electro magnet, spring, and gravity ammeters.

Permanent magnets have the great defect that their magnetism may be temporarily or permanently altered by being brought into strong magnetic fields, such as are found among dynamos. Time also affects permanent magnets, and any of these changes affects the value of the scale readings of the instrument. Hence, if such instruments are used, they should be frequently calibrated or tested to ascertain the continued correctness of the scale reading. It usually suffices for the makers to obtain the scale of the instrument by using a standard ammeter; but if extreme accuracy is desired, or if there is no standard at hand, the electrolytic method must be used. Here is a form of ammeter that has been largely used. A short needle, n s, is fixed on a shaft, P, Fig. 7 (the shaft turns on jewelled

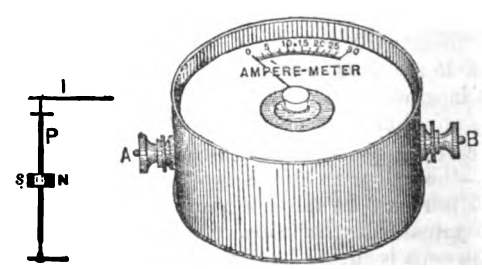

FIG. 7.

pivots), and mounted between the poles of two strong magnets, as shown in plan (Fig. 8). The current to be measured goes through the coils, C C, wound with wire suitable to carry the currents to be measured, for, as Prof. Ayrton puts it, *the test must not alter the thing tested.* If the current

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increases from zero, the needle moves through an angle increasing with the current, and the pointer moving with the needle, points to the value of the current on the side. It may be well to explain a little more fully how to make this scale in the absence of a standard ammeter.

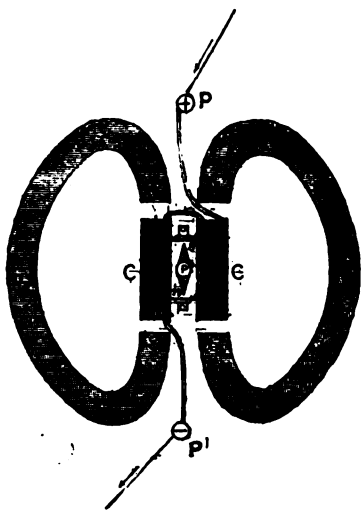

FIG. 8.

Take any scale of equal divisions and put it under the pointer. The zero may be marked when no current goes through the coils. Take an electrolytic cell, say, depositing copper. Carefully weigh the electrodes, which should be movable, for to obtain an accurate scale point the current through the circuit must be kept constant. Connect up ammeter with cell in the circuit, and note deflection of pointer. While the current through the circuit is constant this deflection is constant, and if the cell should become weak and the current drop, the electrodes can be brought a little nearer so as to decrease the internal resistance of the cell, and thus keep constant current. Keep the experiment going, say, 30 minutes, and then find amount of copper deposited, say, 2·958 grammes, or at rate of 5·916 grammes per hour. Now, *one ampere* current deposits 1·183 grammes per hour, so the current used is $\frac{5{\cdot}916}{1{\cdot}183} = 5$, or five amperes. Thus we can mark the point on the scale where the pointer stood during the experiment 5, and in like manner can obtain other points.

Profs. Ayrton and Perry introduced a modification of the Deprez ammeter into England, and have since designed instruments not controlled by permanent magnets. Fig. 9

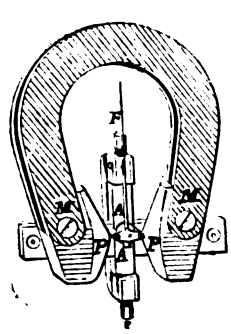

FIG. 9.

shows the form with permanent magnet. The needle is placed in a brass tube between the soft-iron pole-pieces, P P, of the magnet, M M. The spindle carrying the needle also carries an aluminium pointer. The coil through which passes the current to be measured is wound on the brass tube, A A, at the ends of which are soft-iron screws, F F, to assist in adjusting the instrument.

Spring Ammeters.—The introduction of these instruments is also due to Profs. Ayrton and Perry. Here the controlling force is a spring. The important feature of this instrument in the special form of spring employed. The peculiarity of this form of spring, in the words of Prof. Ayrton, is that for a small increase in length along the axis there is large rotation of one end of the spring relatively to the other, the angle of rotation being directly proportional to the axial extension. If, then, one end of the spring is fixed, and the spring be slightly pulled axially towards the other end, a pointer fastened to the movable end will move through a comparatively large angle. This motion of the pointer can be read on a scale.

The spring, S, made of phosphor bronze, is fastened at the bottom of a thin tube of soft iron, B, by the brass cap, D. The cap has a square shank, which fits into a square guide-piece, so that it cannot turn. The spring, C, is suspended by a thin wire, W, carrying a light aluminium pointer, P.

If now, the soft-iron core, B, is put partly into a solenoid,

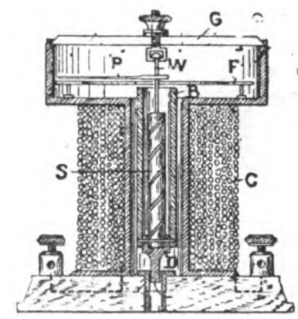

FIG. 10.

a current sent through the coils of the solenoid pulls the soft-iron core, so that a pull axially is exerted upon the spring, C. The lower end of the spring cannot move, but the upper end can rotate, and under the influence of the axial pull does rotate, carrying round the pointer, P, which in the instrument is swinging over a direct reading scale. A section of the complete instrument is shown in Fig. 10, where A C shows the coils of the solenoid, G, the glass top of the instrument, F the scale.

Edison's Ammeter.—In Ayrton and Perry's instrument a soft-iron core is sucked into the solenoid. So, also, in Edison's, but the latter has no spring (Fig. 11). In it we

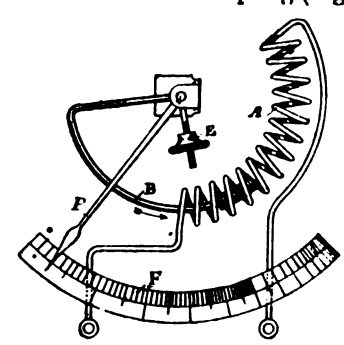

FIG. 11.

have a solenoid, A, with a bent core, B, of soft iron. The core, B, has a counter-weight, E, so fixed, and of such a weight, that the pointer, P, is at zero when there is no current in A.

Weston Ammeter.—A form of instrument largely used in America and becoming a favourite in England is shown in Figs. 12 and 13. Here the coil, C, is placed between the

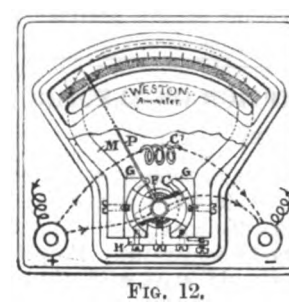

FIG. 12.

poles of the permanent magnet, M. A shunt-coil, C, is placed in parallel with the coil, C. The latter is wound upon an aluminum frame, delicately pivoted, and carrying a pointer, P. A soft-iron cylinder, F, concentric to the pole-pieces, G G, is supported by the brass crossplate, H, which extends across the pole-pieces. The movable coil,

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C, is held in the zero position by two flat horizontal springs, S S, fastened to the ends of the coil one above and one below. The cross-section of the permanent magnet is in the standard instruments 1·25in. × ·3in. I have said

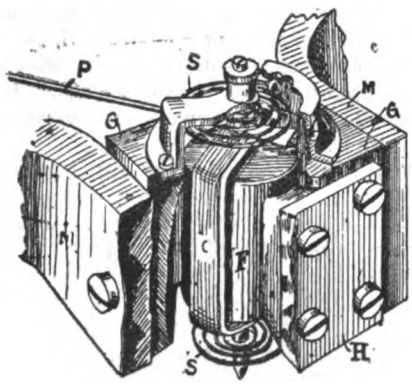

FIG. 13.

that one objection to permanent magnets is their liability to change. After a time, however, this liability to change is small, and the intensity becomes fairly constant. Such a magnet has been called "aged." In the Weston instruments the permanent magnets are carefully artificially "aged." The gap between the pole-pieces and the iron cylinder is ·04in. ; the radial thickness of the coil, including the aluminum frame, is ·015in., leaving a clearance at each side of the coil of ·0125in.

Uppenborn and Schuckert Ammeters.—A very interesting form of ammeter is this, and the construction is simple. Fig. 14 shows the whole principle. The coil, C,

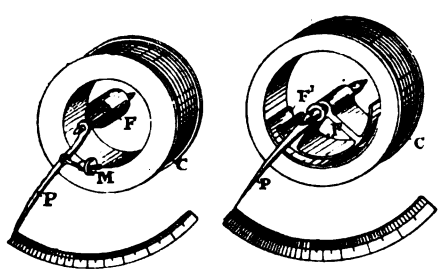

FIG. 14.

carries the current. In the Uppenborn instrument, F and F^1 are two soft-iron cores—F^1 fixed and F pivoted and movable. When a current passes through C, these soft-iron cores are similarly magnetised, and a repellent action takes place between them. The core F^1 is set slightly forward in the direction it is wanted to move. It carries a pointer, which points to zero on the scale when no current is passing. In the Schuckert instrument only one soft-iron core, F, is used, and this is placed eccentrically in the interior of the coil on an axis parallel with the axis of the coil. The core carries a pointer, and is adjusted with the aid of a counterweight, M, so that the pointer is at the zero of the scale when no current passes through the coil. When a current passes, the core gets nearer and nearer to the coil till it touches, when the pointer stands at the extreme position of the scale.

POWER CONSUMPTION ON ELECTRIC RAILWAYS.*

BY A. K. BAYLOR.

The subject of power consumption on electric railways seems to naturally divide itself into two parts: first, the apparatus itself, its efficiency and general construction; second, the handling of apparatus. Properly, a consideration of this subject should start with the coal pile, but it is proposed here to consider it merely in its relation to the electrical apparatus, taking the power as it comes from the engine shaft. One of the first questions bearing on the efficiency of the generating plant that must be considered is whether direct-connected or belt-driven generators are to be used. In a paper recently read before the Pennsylvania Street Railway Association, the writer pointed out that the experience of the last two or three years has shown direct connection to have, in most cases, everything in its favour, and that where land values are high and the units large, these two points alone will dictate the choice of the type of machine. It was at first supposed that the great fluctuation of load inevitable in railway work would introduce a serious menace to the unit—*i.e.*, the engine and generator—when the two were rigidly connected; but this has been shown by repeated experience to be a negligible factor when a properly proportioned flywheel is introduced between engine and armature.

In comparing the two types of machines, the first consideration is apt to be the relative cost. As a direct-coupled generator is usually designed to give a certain output while running at slower speed than a belted generator for equivalent output, it must be large and cost more than the belted machine. From the difference in cost, however, must be deducted the expense of belts, and several other money-saving features must be considered. The direct-connected machine takes less room, saving land and permitting the use of a smaller building. Only one foundation is necessary, instead of two, and although the one foundation must be larger than either of the two necessary for a belted unit of equal power, it will usually cost less than the sum of the two. Furthermore, there are fewer bearings and wearing parts to care for, and last, but not least, a saving in efficiency of from 5 to 6 per cent. according to the proportion of load on the generator. This difference in percentage is due to the fact that the least possible friction loss due to belting is in the vicinity of 4 or 5 per cent., and even if this minimum be preserved at full load it becomes about 8 or 10 per cent. when the generator is running at half load. These considerations will usually effect a decision in favour of direct coupling, unless they are offset by a saving in interest charges due to an unusually low-priced belted generator.

The next point to be considered seems to be the proper division of the plant into units. Generally speaking, perhaps the best investment is made by the installation of three units of equal size, two of which are capable of carrying the full load. This permits efficient running at half load and full load, and leaves one unit always in reserve. It is, of course, desirable for the sake of efficiency and consequent economy of power to run all the working machines as near full load as possible, and to keep "on top" of the efficiency curve, and, with this object in view, some roads have made a division of power into, say, two large units, each equal to one-half the full load, and one small one equal to one-quarter load. This permits full-load running practically all the time, as combinations of these machines will give one-quarter load, one-half, three-quarter, and full load; but in case one of the large units gives out, the remaining one-half and one-quarter unit will have to be considerably overloaded to handle the full load of the station.

It is interesting to note how daily records of current output by readings taken every few minutes will show the separation of the day into distinct load periods which will repeat themselves with astonishing accuracy from day to day when the same general conditions obtain. For this reason, and because it is impossible to keep playing the generator units into combinations to fit all these fluctuations, it is necessary to choose a generator at the outset with a good efficiency curve; in other words, a "flat" curve, one which rises to 90 per cent. or thereabouts, at a comparatively small load, and gradually rises with the load to a high maximum, running then on a practically horizontal line, until the load becomes excessive. As contributing to this result, the machines should run without excessive heating, which means ample capacity in conductors, commutators, and armature, large radiating surfaces, good ventilation, and sufficient bearings. They must run free from sparking up to reasonable overloads, and must have insulation of sufficient resistance to prevent leakages to ground, and after all this they must be kept clean.

Buyers should also remember that the manufacturing companies whose engineers have made these points a matter of special study, and have the experience of scores of plants to guide them, ought to be, and are, in a position

* From *Cassier's Magazine.*

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to judge intelligently of the general proportions best calculated to give a certain result. The buyers should therefore confine their specifications, in a reasonable degree, to a list of conditions to be fulfilled, naming the heating, sparking, and overload limits required, with other general features, leaving the means for reaching these ends—*i.e.*, the size of conductors, number of commutator bars, thickness of insulation, and the thousand and one details of design which go to make up an efficient machine—to the makers. A great deal would be gained in this direction if consulting engineers fully realised that unless they have given the matter enough study to qualify them as generator designers, they may, through insisting on some peculiarity of detail and receiving a generator fulfilling their specifications, get a machine inferior to what would have been furnished had the manufacturer been held accountable for results only.

As bearing on the general efficiency of the system, the line should be of ample capacity and of insulation sufficient to withstand the potential at all times. The ground return capacity should, of course, be equal to the overhead feeder. An abundance of overhead copper with bad rail bonding, with, perhaps, open circuits, is an absurdity. As affecting the life of the motors, the feeders should be distributed to deliver as nearly as possible an even potential all over the line, and while the voltage should not be allowed to drop too low, it also should not be raised to any considerable degree above the normal point, as this puts the motor insulation under undue stress. On this account, when cars run directly past the power-house, the feeders should not attach directly to the line, but should spread in either direction and feed back to this point. It is evident that when a motor has become dusty or moistened in service, its insulation resistance is reduced, and any excess in potential above its safe limit will result in punctures of the winding and other leakages to ground; whereas, if the pressure be kept inside this limit, if only by a few volts, the bulk of such trouble may be avoided.

Of course, the motor is another factor of prime importance in the economy of power, and what has been said under generators regarding efficiency will apply in a general way here. A motor should be as light as is consistent with strength and power, and should be compact and protected by its frame. The most important consideration in the purchase of motors may be safely said to be cost of maintenance, but this has no direct bearing on the economy of power, much as it has to do with economy of operation. As a power saver, the most important part of the car equipment is the controller. The time has gone by when it was necessary to draw comparisons between rheostatic and series-parallel control in considering equipments; yet a good many lines are operating rheostatic controllers without apparently appreciating the loss they are sustaining. Aside from the out-and-out saving in power by the use of series-parallel control, which amounts to a clean 25 to 40 per cent., according to the series, it should be remembered that the necessary generating plant for operating with such controllers is much less than that required for the same car service under rheostatic control, not only because of the average economy of power, but because the momentary fluctuations of load, which must be taken care of, are much less violent, and this latter condition holds good in any case, even for a high-speed road making few stops, and where the motors are kept in multiple so much of the time that the average power consumed is practically the same for both methods of control.

Another practical advantage is found in the possibility of running all the cars at half speed in case of the disabling of half the power-house capacity. This is an important consideration, for instance, on a stormy day, perhaps during a snowstorm, when the first desire of patrons is to get aboard cars in large numbers, away from the weather and to be carried to their destination. At such a time the number of minutes consumed in getting there is usually a secondary consideration. Tracing up the subject of operation at the power-house, one of the most effective economies is the use of recording wattmeters registering the load continuously. By this means, and in connection with readings on individual cars, load curves may be established, representing fairly (by the division of the day into load periods, as mentioned above, and the current output during those periods) the power which should be consumed to handle a given traffic. In this way a careful and intelligent comparison may be drawn between different days in a season and between days of similar character. Wattmeter readings on separate cars are of especial importance, establishing, as they do, for the unit what the station readings show for the whole system. Repetitions under all conditions will show whether a certain car should consume 800 or 900 or some other number of watt-hours in running a mile, and any sudden or wide variation to-morrow from the standard load readings of to-day and yesterday will indicate a leakage of some sort and attract prompt attention. Without such a system of checks in the delivery of current, there is nothing but the sluggish coal pile to betray any irregularity in power consumption. In addition to these guards, a recording voltmeter should be used at the station, or a voltage record kept at very frequent intervals. With due allowance for over-compounding, the theoretical record would be a circle, and in practice, with a fairly constant load, the record should approach this standard. If the voltage undergo wide fluctuations, comparing different times of the day, the generator is faulty, or the station man is negligent, and in either case the motors suffer, and they not only require a greater average current to do a given work at reduced voltage, but they will consume more watts in doing it.

A very great factor in saving power is the degree of intelligence of the motormen. They are too often put upon cars with scarcely any preparation and are then practically left to their own devices, and naturally handle their cars uneconomically. They will often move the controller handle around the dial without regard to the notches, passing into No. 2 before acceleration of the first position has been felt, and so on to Nos. 3 and 4. It sometimes practically amounts to throwing the handle immediately into the first position. As far as economy of power is concerned, such men might almost as well have rheostatic controllers. The pity of it is, too, that as a rule the men are not to blame, never having received proper instructions. A valuable aid in the education of motormen is the use of an ammeter in the motor circuit, in plain sight, so that during their run the men can see the fluctuations of the instrument and note the results of incorrect handling as compared with the right method. The plan followed by Mr. Know, of the Chicago City Railway, is certainly an excellent one. He has printed curves, laid upon one plot, comparing the current fluctuations with right and wrong methods of starting, posted around the car barns and employés' rooms as a graphic object-lesson which has resulted in an economy of power. Further than this, motormen should be instructed in the car circuits, with diagrams showing the connections at each position of the controller. With this knowledge a conscientious man would involuntarily make an effort in the right direction.

Another great coal consumer is the brake. A great amount of power is wasted by men who throw their controllers into contact before thoroughly releasing brakes, even when there is no danger of backing. They also throw on the brake before throwing off the power. Very few men understand or attempt to use the momentum of their car to advantage. They will run with power on close up to a leading car and then apply brakes, when they might coast many feet, using no current whatever. This momentum may also be used to advantage on curves, switches, or wherever there is unusual resistance. The careful scheduling of cars with respect to grades may be an important economy, and although it is a complicated problem, it is worthy of more attention than it is usually given. Care should be taken to keep bearings and running gear in good condition and to maintain track gauges. The wheels upon any truck should be made of the same diameter (a precaution frequently overlooked) to permit the motors to wear in perfect unison.

A full consideration of this heading leads into every branch of the operation of electric railways, and although the efficiencies of apparatus and the direct handling of it are the first things to consider, every fault in system or operation is directly or indirectly an attack on the coal pile.

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A MERRY CHRISTMAS.

It is almost impossible at Christmas time to write on technical subjects when we know that the words written will in many instances reach readers during the week when only that which is glorious in mundane affairs should be recognised. The most violent partisan, the harshest critic, could not write anything obnoxious at a time which breathes naught but peace and goodwill. There is no technical subject about which we are all agreed, but there are many about which our differences are merely on matters of detail. The goal aimed at is the same; the paths to arrive at that goal are different. To-day, then, let us refer to a subject about which there can be little divergence of opinion—the subject of education. Everyone admits that education is necessary for success in life, but we are not agreed upon the kind of education necessary to fit a man for technical work; and ofttimes wordy warfare takes place between speakers and writers, all of whom are desirous of doing good, but each is speaking or writing of a different thing. Is it not singular that the agitation for technical education is as keen now as it was three-quarters of a century ago, or perhaps it would be better put the other way about—and was as keen then as now? If men knew what they really wanted, would this talkee-talkee go on for so many years without tangible result? Do we really admit that, in the first place, education, in the second place, technical education, is so all important? There is no doubt about such admission. How, then, can we account for the bitter cry still going on for technical education, except on the one hypothesis that no one as yet has satisfactorily defined what is really wanted? Seventy years ago we read of Henry Bell—the real designer of the steamboat—that "he also constructed a steam-carriage to ply upon a common road, but, as the high-pressure engine was indispensable, and as it was suppressed by Act of Parliament, his invention was abandoned." This week we read of an innovator being fined for running a motor-carriage on the highway. What can be said of educational progress in this particular direction? Brougham, at the first annual dinner of the London Mechanics' Institution on December 2, 1824, said, "He could not help thinking that those who should live forty or fifty years hence would witness such a change in the condition of mankind, from the existence of these institutions, as would be really astonishing; and he doubted not that those who were present would, if spared only ten or five years, see great improvement, if the same spirit continued, in the condition of mankind, arising from the diffusion of knowledge; and they would recollect that knowledge was power." Now, we who live later know that the energy which founded "Mechanics' Institutions" expended itself, was revivified in the forties, gathered vigour in 1851, and has continued to expand ever since. Is not much of the energy wasted because of the indefiniteness of the aim? The same publication that tells us of Brougham and Birkbeck quotes a note from Adam Smith to the effect that that little article, a pin, passes through eighteen different hands in the course of its manufacture. The question may well

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be asked when visiting a machine shop, What is the particular technical education that will make this or that man more effective in the performance of his duties? In the vast majority of cases a man pursues one class of work all his life. From the industrial and economic point of view, then, is it not a waste of energy to ignore his particular work and teach him something else? Are we not trying to fit everybody to become masters, and designers, rather than workers? Do we not neglect almost all the technical education that will assist to make home life happy and the workman's labour more efficient in order to give him notions which he can never use? In doing this, do we not teach a smattering of everything and get thoroughness in nothing? But Christmas is with us, and we only ask these things to know if our aims are really direct, and if not, cannot they be made more direct?

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Justice needs that both be heard."

THE INSTITUTION.

SIR,—Some years ago I found myself in identically the same position as Mr. Raworth was at the last annual meeting, and although the proposals I wished to make were, I think, calculated to enhance the usefulness of the Institution, I refrained from getting 10 members to ask for an extraordinary meeting. Put it as we will, an extraordinary meeting convened at the request of members has an appearance of hostility to the Council, which none of us want. I venture, however, to express the hope that the Council will themselves appoint a committee for the purpose of considering whether a revision of the rules has not, by reason of the vast increase of members, become desirable. If the committee arrive at the conclusion that the rules may be improved upon, the proposed revision could be circulated amongst the members, and the Council themselves might call an extraordinary meeting.

Having said so much, perhaps one ought to suggest one or two alterations that seem worth consideration. Do we not use up our presidents too quickly? Why should they not keep office for two years? As to qualification, the second rule is, to say the least, vague. Is it not an anomaly that the senior vice-president should be entitled, in the absence of the president, to preside at a Council meeting, and yet may by some not be considered eligible for the office of president?

And last, though not least, surely in a large Institution such as ours has become there ought to be some legitimate and recognised method by which members may at the annual meeting bring forward proposals for the benefit of the Institution without being placed in the invidious position of being obliged to move an amendment on the report of the Council.—Yours, etc., S. FLOOD PAGE.

THE ARC LIGHT.*

BY PROF. SILVANUS P. THOMPSON, D.SC., F.R.S.

LECTURE I.

(Continued from page 660.)

We have in general the same sort of sloping things as previous experimenters have found. But the lines that correspond to different pressures all slope down from right to left. They are not all straight, though straight over a considerable range. The "one atmosphere" line is not quite straight, for it begins to turn down when the length is small. But its straight part points toward 40 or 39 according to the current that is being employed. Now, if my theory is true, that the arc temperature is that at which carbon is vaporised, it follows that if you put on the pressure you ought to have exactly the same sort of effect as happens in boiling liquid when you put on pressure: you raise the temperature of boiling. In the present case you raise the temperature of evaporation, and require more energy to make it boil—that is to say, it will boil, other things being equal, with a bigger back E.M.F. The diagram shows the line for two atmospheres, for four, for six, and for ten. Let us pass at once to the last as being the extreme case. The "ten atmospheres" curve points back to 48 volts instead of 39, proving, in fact, that more work is done by the current in going through the arc when it is made more difficult for the carbon to evaporate from the crater into the arc itself. There are some other things which might be noticed in this figure. For instance, when working in a vacuum, short arcs require less E.M.F., and long arcs a greater than is required in air at the ordinary pressure. The next diagram, Fig. 8, is also one of Duncan's, plotted out in a different way. Here he is employing a constant length of arc, but varying the pressure. As you increase the pressure from vacuum first to one atmosphere, then to two atmospheres, and so on, you notice what happens. With a very short arc there is a continuous increase in the volts required, but if the arc is $\frac{1}{8}$in. long, and you pass from vacuum to one atmosphere, you want fewer volts. It is easier to send an arc through air than through vacuum when it is only $\frac{1}{8}$in. long, but after that the electric pressure required increases. Suppose you begin with a $\frac{1}{2}$in. arc, there is a very distinct lowering of the voltage, but a little over 5 per cent. in amount. Yet, on raising the pressure above one atmosphere, the voltage again increases. All this points to something not yet discovered.

Now, let us try to sum up what is known on this point. Carbon, the most refractory of known substances, has a definite temperature of volatilisation when the pressure is kept constant. Change of pressure will change that temperature. However intense the heating effect of the current, however fiercely we pour in energy by means of the electric circuit, we cannot raise the free surface where the carbon is evaporating above that limiting temperature. Increasing the rate at which heat is poured in will simply increase the rate of evaporation. Further, carbon is found at these elevated temperatures to have chemical properties of the most active kind. No known compound exists that is not dissociated at arc temperatures. Put any of the most refractory substances known—lime, magnesia, alumina, asbestos—into the arc, they are dissipated, reduced, volatilised; mix any of them with the carbon, and one finds that, without exception, the effect of their presence is to reduce the temperature, to lower the degree of luminosity, and—what is most significant—to lower the apparent back E.M.F. Increase of pressure, however, raises the temperature and raises the luminosity. What a glimpse this gives us of the possible state of things going on at the surface of the sun. For some reason—into which I need not enter—the temperature at the sun's surface is very high, higher, to judge by the radiation, than that of the crater of the arc. Also, the pressure of the solar atmosphere, at the level of the sun's surface, must be much higher than the one atmosphere of our air. At such temperatures (and pressures) all known chemical compounds would be dissociated into their elements, and all the known elements would be volatilised. The last element to be volatilised would be carbon. Are we not justified, then, in hazarding the suggestion that the luminous surface of the sun, to which it owes its brightness, is in reality a surface of incandescent carbon? If not, what else can it be?

Remarks since added, October, 1895.—It is only just to add, in view of later researches, that there is some evidence not concordant with the views put forth in this lecture in January. Experiments made in Ireland by Mr. W. E. Wilson go to show that under certain conditions the light given out by an arc lamp is reduced in brilliancy when the lamp is burned under a pressure of several atmospheres. Mr. Wilson considers that he has shown that the intrinsic luminosity is lowered. If this should be established it will, of course, mean that the temperature also is lowered by pressure, and that therefore the temperature of the arc cannot be considered as dependent upon the temperature of volatilisation of carbon. But it remains to be proved whether the temperature of volatilisation of carbon is so lowered by pressure. The matter is complicated by the circumstance alluded to in the lecture, that the melting point of carbon is so close to its boiling point. In the absence of any knowledge as to whether at the fusion point any change of volume occurs, and whether such change be an expansion or a contraction, it is impossible to say whether increase of temperature will raise or lower the melting point. All one can say is that the question raised is still in suspense, and that for the present Mr. Wilson's observations are distinctly against the theory put forward.

Further, in September, 1895, at the meeting of the British Association, Prof. Ayrton and Mr. Mather communicated a paper on the apparent back E.M.F. of the arc, which they had been examining by a new method of electrical measurement. This method cannot be discussed here, but there are grave doubts as to its validity. Using this method, the extraordinary result was obtained that the supposed back E.M.F. is a negative

* Cantor lectures delivered before the Society of Arts.

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quantity—that is to say, instead of an E.M.F. opposing the current, they found a forward E.M F. helping it. If this were true, it would involve the admission that the arc would be acting as a source of electric power, and it would also involve the admission that the resistance of the column of vapour of the arc is greater than can be accounted for by the fall of potential per unit of length, both of which conclusions would be inadmissible.—S.P.T.

Researches of Prof. Ayrton.

Any account of the physics of the arc would be incomplete which did not include a reference to the researches of Prof. Ayrton. I listened, when at the Electrical Congress at Chicago in 1893, with the utmost delight to a very elaborate paper which cleared up a number of doubtful points, and gave us far more complete details about the phenomena of the arc than anything hitherto available. The same sort of observations had been made by Prof. Ayrton and by Mrs. Ayrton as those which I and other observers had made in time past. They had been carefully comparing the length of the arc, the voltage, the current, size of crater, and so forth, but over very much larger ranges and with more perfect appliances than any previous observer. In particular, they had found that if after adjusting any of the conditions as to length, current, and the like, a sufficiently long time (exceeding half-an-hour, if I remember aright) were allowed to elapse, the crater and peak settled down to a special form corresponding to those conditions. And that to every change of length or of current there corresponded a different form. Only when each separate experiment—and there were hundreds of them—had been carried on for a sufficient length of time could readings of voltage be obtained which were truly normal. Results obtained in this patient way, when plotted out in curves, showed the most surprising regularity. Instead of the broken curves (such as Frölich's, Fig. 2 *supra*) of the earlier observers, curves of smooth outline were obtained. Also the observations had been pushed further. The curves had been carried to extremes—for very large currents and very small currents; to very high voltage and very low voltage; with very short arcs and very long arcs; with very big craters and little craters. Those curves contained by far the most complete account of the natural history of the arc than any other thing attempted by anyone else. I looked forward to the publication of these results with great interest. Sad to relate, the scientific man to whom Prof. Ayrton entrusted the paper before he left America to return home, after keeping them beside him for some months without sending them to press, allowed his negro servant to use them for lighting fires. Only a few fragmentary notes remain. I have urged Prof. Ayrton to renew his labours and repeat investigations of such importance, and I am glad to say that we are likely to have something soon from him to repair the loss. But until that appears I shall feel, at any rate, as though a very large part of the physics of the arc was still wanting.

Note added, October, 1895.—During the course of the current year Mrs. Ayrton has communicated to the *Electrician* a series of papers embodying the fragments of the research of which the records were so shamefully treated, together with the results of renewed experiments. Mrs. Ayrton has further communicated to the British Association, in September, 1895, a paper on the formulæ for expressing the relation between voltage, current, and length of arc. The results of these observations are so important that it would be an injustice to their merits to attempt to summarise them here. Mrs. Ayrton's formula has been added to those exhibited in the table.—S.P.T.

Arc Furnaces.

From the time of De la Rive and of Despretz, experiments have been made on the use of the arc for electrometallurgical

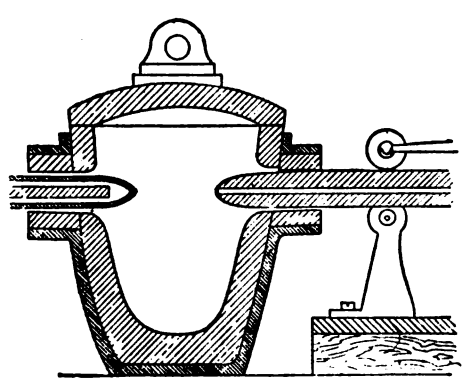

Fig. 9.

processes, owing to its very high temperature and the reducing action of carbon. Napier, in 1845, presented to the Society of Arts an electric furnace intended for the reduction of metals, consisting of a lined plumbago crucible, into which a carbon electrode was introduced. Sir W. Siemens was amongst the first to revive the construction (Fig. 9) of an arc furnace. He introduced, through the sides of a crucible refractory and non-conducting material, two pencils of carbon, between which the arc was formed. Since then great progress has been made by Cowles in the production of aluminium alloys, and by Moissan and others in the reduction of metals. A wide field for commercial development has thereby been opened.

Another thing has to be done—the chemists must go to work. The chemistry of carbon at high temperatures is one of those things that ought really, now that the supply of electricity is so common, to be easy to experiment upon. The electrician provides what the chemist wants: the means of making a high temperature with an arc. What the chemist has not yet worked out is the chemistry of carbon at high temperatures. Thus we know that chemists have not found a compound yet that cannot be decomposed into its elements at the temperature of the arc in the presence of carbon, so that carbon appears to be the nearest approach yet to the universal solvent. When I deal next week with the optics of the arc I shall recur to this matter of the behaviour of carbon itself; but from this point onwards—that is to say, in my next lecture and in the one afterwards—I do not propose to return to any of the other materials that have been proposed. It simply is waste of time at present to deal with arcs made with any other material than carbon; in fact, I will take this one of the 70 known elements, and confine myself to it. And I will deal with that element in a particular way—viz., as used in the making of an arc at about 40 to 50 volts, leaving aside all high-voltage phenomena, all vacuum phenomena, all the abnormal phenomena of the arc, confining myself to the arc as we know it for industrial purposes.

LECTURE II.

Optics of the Arc.

The optical phenomena of the arc are nearly as complicated as are those electrical phenomena which occupied us a week ago. They vary with every different kind of carbon that one may employ, with every different value of current that one may use with a given carbon, and with every different kind of adjustment that one may have in the lamp that regulates the carbon. In a lecture such as this one can only deal with a few salient facts in a few typical cases.

Distribution of Light of the Arc.

The first and most important case to consider is that of the normal arc produced by the continuous current. There are two possible general cases of this also. The first case is that in which the current descends from the upper carbon to the lower, and is generally adopted for the lamps used for outdoor work. The second case, which is rather exceptional, and is only adopted in certain cases of indoor illumination, is that of the inverted arc, where the current ascends from the lower carbon to the upper. As the former is the more usual, we will deal with it. In this lantern we have now an arc formed, the particular regulator employed here being a Serrin lamp of the old-fashioned sort. I use it rather than any more modern mechanism simply because it is convenient as a table lamp. In front of the arc, which is formed here between these carbons, we have a lens in order to project the view of the arc upon the screen, and we can, if need be, introduce in front of the lens an erecting prism to rectify the position of the image on the screen You now see upon the screen the image of the arc formed between the carbons. The positive carbon, with its luminous crater, is at the top; the negative, with its characteristic peak, is at the bottom; and in between them is a violet-coloured flame or arc, consisting of the column of carbon vapour through which the current descends. By a very small adjustment of the upper carbon I arrange the position of the points so as to enable you to get a better view of the crater. Here is the first

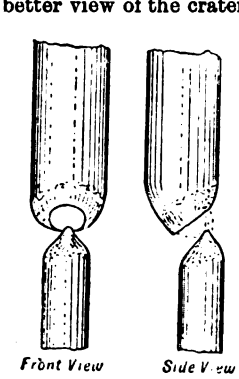

Fig. 10.

and most obvious optical fact, that the light comes from the white-hot surface from which the carbon is evaporating. About 90 per cent. of the light comes from the crater and about 4 or 5 per cent. from the negative peak, while comparatively little light comes from any other part. Around the rim of the crater there is, however, a region that is less luminous, not so

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hot, and of a redder colour, and there is a certain small percentage of light—not more than 3 or 4 per cent. of the total light at most—emitted from the intermediate flame. Now, of course, there results from this a peculiar distribution of light in the space all round; the light is, in fact, thrown mainly downwards.

When it is desired to throw the light, not symmetrically downwards, but to project more of it in a horizontal direction, we resort to the device, introduced first by Duboscq, of displacing the line of the carbons so that the negative peak instead of being exactly under the centre of the upper carbon is brought a little forward (as in Fig. 10). The crater then forms obliquely, with the negative peak in front of it. This effect I will now produce by simply shifting the upper carbon backwards. As I gradually displace the upper carbon to one side the form of the crater will change; the positive carbon will burn away more on one side than the other. It takes a few minutes to change its shape, during which time the light will be unsteady, and when the new form has been assumed we shall find that the light is thrown mainly on one side, as is desired for projector purposes and for use in the optical lantern. We may have to let the arc burn untouched for something like half an hour in order that the final shape of the surfaces may be properly assumed. As the maximum emission of the light is at right angles from the luminous surface we shall now have obviously a different distribution in the illumination.

Distribution Curves.

For a period of 15 years or more back it has been customary in the laboratory to measure and plot out the amount of light given by arcs in different directions and to study the curves of distribution produced in that way. Two examples of these are shown in Fig. 11. Curve A relates to an arc produced at a

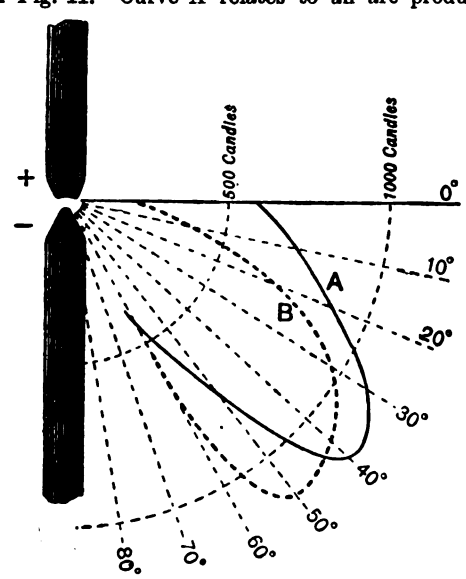

Fig. 11.

constant voltage on a low-pressure system of supply; Curve B to an arc produced with an unvarying current on a high-pressure system of supply, other arcs being in series with the one measured. The mean current for both was about the same. The data of the measurements (which are taken from an American source) are given in the table below.

(A) Low-pressure.		(B) High-pressure.	
Angle, deg.	Candle-power.	Angle, deg.	Candle-power.
0	593·7	0	210·5
10	712·1	10	407·4
20	866·3	20	687·4
30	1,094·0	30	977·1
40	1,183·0	40	1,179·0
50	682·2	50	1,140·0
60	495·4	60	595·7

If we select some photometric arrangement which will enable us to measure the amounts of light given out in different directions horizontally and at different angles downwards, we can then plot out along these angular directions the amount of light so measured. The distribution curve, marked B in Fig. 11, shows that a little light is given out in an absolutely horizontal direction, that is because in that direction the lower rim of the crater throws a little light sideways. At an angle of 10deg. downwards there is a little more light, and at 20, 30, 40, and 50 degrees one finds that there is an increasing amount until you come to the maximum in one particular direction, which, in this case, is about 50deg. from the horizontal. As you go further along you find that the light suddenly diminishes, not absolutely abruptly, but very rapidly, while absolutely straight down there is no light thrown at all. Obviously, in that case, there is no light because the bottom carbon and its holder throw a shadow. The Curve A in Fig. 11 is another plot taken from a different lamp under different circumstances. Let us now compare the curves so plotted with Fig. 12, which shows a plot relating to an alternating-current lamp. In such lamps the two tips do not materially differ in form from one another provided the quality of carbon is alike and the pencils of equal thickness.

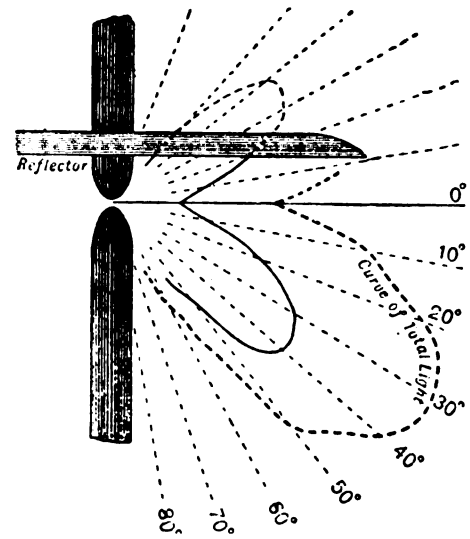

Fig. 12.

Both tips take the form of a blunt peak. This form would be exactly alike were it not for the fact that the hot air ascending at the sides heats the upper carbon more so that it becomes slightly more coned than the lower one. In this case the black curve represents the amount of light in various directions. Some is thrown downwards at an angle and almost an equal amount is thrown upwards at an equal angle with intermediate values in intermediate directions. But if a reflector is interposed to catch the light that is going upwards and throw it also downwards, one obtains the distribution plotted out in the dotted curve.

(To be continued.)

INSULATION OF HIGH-PRESSURE CIRCUITS.

The New York *Electrical Age* of December 7 has published an abstract of a paper read by Captain W. Brophy before the Boston Electric Potential on the insulation of circuits having a difference of potential of over 2,000 volts. After maintaining that all such circuits should be placed underground, Captain Brophy makes some strong remarks on the way in which overhead lines are erected in America. "The so-called insulating covering," he says, "in use at the present time for high-potential overhead circuits is worse than a delusion and a snare. I believe it would be better to hang out the danger signal at once, by using bare copper wire, than to continue the use of this flimsy fraud that affords no protection to human life or property, but lures innocent people on to injury and death. Knowing the worthlessness of the material, it becomes necessary to use the best form of insulating supports." Iron poles Captain Brophy condemns altogether. "They are a relic of barbarism that should be relegated to the scrap heap, and any attempt to patch them up only serves as a thin disguise to the danger that lurks within them. Twenty-five to forty feet of wood between the iron and the ground means that much insulation, while 100ft. of iron only means what the glass insulator, wooden pin, and cross-arm afford. The waste of energy due to the iron poles on the long circuits is simply enormous. Where such circuits are placed on the modern iron and steel structures they become a source of danger to persons who have occasion to handle these or other wires on the same or other fixtures."

DISTRIBUTION OF POWER IN COLLIERIES.*

BY LLEWELYN B ATKINSON AMICE.

The present position of the coal-mining industry in the United Kingdom is one deserving of the most thoughtful consideration by all who are interested in the future commerce of the country, and the object of the present paper is to point out how some of the difficulties under which this industry at present labours may possibly be met. The difficulty to be contended with at present may be briefly stated. The possible output, indeed the output at which a reasonable profit can be earned, is greater than the demand at present prices; and even this demand is threatened by the decreasing price of foreign coal.

* Paper read before the South Wales Institute of Engineers.

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From whatever point of view it is looked at, the question resolves itself into stimulating demand, and this can only be effectually done by lowering the selling price, which cannot at present be done without extinguishing the profit.

To decrease the cost at the collieries there are, broadly, three courses: (1) to decrease the payment per ton to the mineral owner; (2) to decrease the wages cost per ton raised; (3) to decrease the fuel expenditure per ton raised.

The first of these is a matter outside the scope of this paper, the second will be briefly touched upon, and the third will be dealt with in some detail. In the course of the last eight or nine years the author has been in close contact with mining operations in various parts of England and Wales, and the opinion has gradually been forced upon him that there is a very large margin of economy in wages and fuel to be effected. This arises from the fact that economies in labour and fuel which are studied and insisted on in engineering and manufacturing industries are hardly considered in coal-mining, at all events in the majority of instances. This broad fact must appeal to every mind that, whereas in almost every manufacturing process or industrial operation the product per man has nearly doubled and the consumption of fuel been halved within the last 15 years, in coal-mining the product per man has been practically stationary, and the cost of fuel per ton raised probably nearly so. This is frequently attributed to the stringency of mining legislation, but legislation has largely affected other industries also, and the result cannot be altogether attributed to this cause.

It would be a long task to enumerate the causes which, in the author's opinion, contribute to this result; but, broadly, it appears to him that what is required is to do in mining what has been done in every other department of industry, and to lower the cost of wages and material per ton by increasing the product per man and per pound of fuel by the following means: (1) improved organisation, both in the working, and more especially in the original laying out of the scheme of working a colliery; (2) more superintendence and supervision underground by thoroughly well-informed mining and mechanical engineers; (3) the greater use of mechanical power instead of human and horse labour, and a more economical production of that power. In short, substitute brains and mechanical power for human labour.

It has been already stated that the immediate object of this paper is to deal with the question of the economical production of power, but a few remarks on the subject of mechanical power in collieries may be useful. The getting of coal resolves itself into cutting and filling and hauling to the pit bottom. In the great majority of collieries both cutting and filling are done without using any mechanical power whatever, and the progress made in introducing mechanical coal-cutters is slow, at all events in this country. A considerable experience extending over some years with coal-cutting machines in various collieries and various parts of the country justifies the author in saying that there are hardly any seams under 3ft. 6in. in thickness that could not be more cheaply worked by mechanical coal-cutters than by hand labour, and with a better product of round coal, but that in probably not 5 per cent. of the collieries of the country is the existing organisation of the filling and haulage sufficiently good to enable machines to be worked with that regularity which will make them pay. This is the secret of the otherwise unexplained fact that some few collieries have been and are worked by machinery with marked success, whilst the reverse holds good of the majority of cases in which it has been tried. Organisation and superintendence, those are the only secrets of success in cutting coal by machinery; till they are forthcoming, mechanical assistance in this direction must be postponed. In thin seams much might no doubt be done to apply mechanical power to reduce labour and breakage in filling the coal, but the same remark applies as to coal-cutting. The use of machinery in the coal face would so much reduce the length of face under work for a given output that the roads on to the face being less in total length, could without increased cost be kept in a condition enabling mechanical haulage to be used right up to the face, doing away with horses and ponies altogether. These are some of the directions in which mechanical power may be looked for to profitably enable the output per man to be increased. But before this can be done much will have to be done to improve the general organisation both above and below ground. And this may well be commenced by the economical laying out and conduct of the arrangements for the generation of power above ground.

Consider the conditions under which this is at present carried out. Generally speaking, when sinking operations are completed, a winding-engine is put down. Subsequently, as the workings extend, haulage is considered, and some plant, either steam, compressed air, or electrical, is provided for this. Later, perhaps pumping becomes necessary, and again a plant (perhaps on another system) is put in. There are various engines at the surface for the screening, repairing-shop, and other purposes. All these are of uneconomical types, so there ensues at every point waste of heat, waste of steam, particularly when, as in some cases, separate boilers are put down for each plant. And the answer to any criticism generally takes the form: "Oh, fuel is so cheap at a colliery that it does not matter." Why is the fuel so cheap—that is, of such low value? Because it is so small—smashed in hewing, smashed in filling, smashed on the screens, due to imperfect methods and appliances at every point. But at any rate it is worth at least 2s. 6d. per ton, and it is generally estimated that from 5 per cent. up to even 10 per cent. of the total output by weight of the collieries is consumed at the surface, and this means, even taking the lower figure, about 9½ million tons, worth about £1,190,000 per annum.

In has been stated by Mr. Foster Brown that the probable consumption of coal in colliery engines, taking an average, would be not less than 6lb. per horse-power hour. Taking this to refer to indicated horse-power, it is possible to produce the same power with 1½lb. of coal, or even less, hence it may be fairly said that there is a possible saving to be effected of 75 per cent., worth annually nearly £900,000. It would probably be well within the mark to say that the saving to be effected in labour of handling, and in the maintenance of boilers and appliances for consuming this, would be worth, in addition, say, 65 per cent. of the above sum, showing a possible economy of, say, 1½ millions sterling per annum, a sum equal to over 2 per cent. on the total value of the coal raised, or about 3¾ per cent. of the whole wages annually paid in the mining industries; and if the coal were raised unbroken, so that its value was equal to the average value of the coal sold, these figures would rise to 3 per cent. of the value of the total coal raised, or 6 per cent. of the wages paid.

It may be stated at once that to realise these economies the power required must be produced by compound or triple expansion condensing engines, appliances almost unknown in colliery work, and to do this there is no doubt that the whole power required at the colliery must be produced in one or at most two engines, and distributed with as little loss as possible to the points where power is required. There are various methods of distributing power, but some of them are only applicable to particular cases, or in particular circumstances; the only two of general applicability are compressed air and electricity. Of these, whilst under favourable circumstances compressed air can be made to give a favourable efficiency, its application in mining is discounted by two important considerations of economy. To utilise compressed air with efficiency (1) the pipes must be free from leakage, (2) the air must be heated before being used. These two conditions are practically unrealisable, and hence the efficiency of air transmission in collieries is and must necessarily be low. The cost of plant and extended air-mains is also high. The advantage, therefore, in point of view of first cost and efficiency as a means of distributing power rests with electricity, the economy of the cables compared with the air-mains, and the facility for extension and alterations to the position of the machinery make electricity an ideal means of distributing power.

There is, however, a question to which I must refer—viz., that of safety. This question of safety is one which has from the first introduction of electricity in mining been prominently before engineers; though it may be noted that among those who have had practical experience of its use in mines the objection is rarely raised. In a paper read in 1891 before the Institution of Civil Engineers by the author, in conjunction with Mr. C. W. Atkinson, this question was somewhat fully dealt with, and certain conclusions were arrived at which time and experience have gone to confirm, but, as this question is to some minds still an open one, and as additional experience has added to the knowledge of the subject, it may be well to deal with it again at some length.

There are two distinct questions: (1) the safety of an electric motor, which may spark at the commutator; (2) the safety of a system of cables, which may be ruptured whilst carrying an electric current.

Dealing with the first of these, it has been shown from theoretical considerations and by practical tests that the amount of sparking which exists with electric motors of good construction is unable to ignite firedamp, owing to the fact that the temperature is never sufficiently high, and it is only, therefore, in exceptionally abnormal circumstances, such as a brush falling out of its holder or becoming displaced absolutely on the commutator, that the inflammation of firedamp can be effected; and it has also been shown conclusively by experiment that there are in the market methods of enclosing either the whole machine or the armature and commutator, or the commutator alone, which, even under these abnormal circumstances, entirely prevent either the access of firedamp or the ignition of firedamp outside the machine.

Practical experience is in accord with experiment and with the principles named, and the author knows of no recorded instance where there has been an accident from the use of an electric motor in a coal mine. In connection with this, reference may be made to the question of "commutatorless" motors worked by multiphase alternate currents. As the principles on which these motors work are little understood, the author has appended to this paper some notes on the subject,

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but a few points are especially worthy of consideration. The first is that although such a motor may have no commutator, if it has to be regulated as to speed, or to start with the load on, it must have brushes and current-collecting rings, in which case the displacement of the brushes under abnormal circumstances may have in a modified proportion the same result as in an ordinary motor. Another circumstance in connection with such motors as at present constructed is that the maximum turning moment they will give has a limiting value, beyond which it decreases as the load increases, even although the current increases, and that at any other than the normal speed the efficiency rapidly falls. Curves are given showing the maximum turning moments given at different speeds, and the efficiencies are shown. For comparison, similar curves are given for a motor in which the speed is controlled by varying the strength of the magnetic field, using continuous current. A further point is that with such motors the losses in the cables and the dynamos, which with continuous currents are proportional to the power transmitted, are not proportional in the case of alternate currents, whilst, in addition, as 250 volts alternating will give the same "shock" as 500 volts continuous, which is generally treated as the maximum advisable in a colliery, the cables have to be of about twice the area of section for the same power; hence these various considerations contribute to this, that the advantage of such motors at full load and full speed are to be balanced against their disadvantages at less than full load and at other speeds, and in the particular case of colliery transmission these points are large factor.

Returning now to the second point in the question of safety—viz., the possible breakage of a cable. This may be at once overcome if the cables are buried below the surface, but as this method has the disadvantage of expense, and frequently of deterioration of the cable, we may consider the case of a cable hung from the walls or timbers. In this case, if the cable does break, the ends are quickly parted, the spark may continue for the fraction of a second, but it has been shown by the experiments of Messrs. Wüllner and Lehmann at Aix-la-Chapelle, which experiments were accepted as conclusive by the Prussian Firedamp Commission, "that even violent sparks from rupture of the current, accompanied with the explosion of fragments of iron in a state of combustion, had no effect on the inflammation of firedamp." Considerable light has, in the author's opinion, been thrown on this question by the facts recently stated by Prof. Vivian B. Lewis. It appears that the ignition of firedamp arises in most cases, not from the raising of the temperature to the ignition point of firedamp, which is very high, but by the raising of it to the point of its decomposition with evolution of hydrogen, which, becoming ignited, eventually ignites the firedamp. This requires two things: (1) time (and Prof. V. Lewis states that 10 seconds is in some cases necessary); (2) the maintaining of a particular mass of gas in contact with the point where the heat is developed long enough to effect the operation quoted. Neither at the commutator of a motor, nor at the point of rupture of a cable, are these conditions fulfilled. In the face of the facts and experiments and experience now at disposal, those who raise the objection to electricity in mining on the ground of safety ought, in the author's opinion, to bring some proofs of that danger if it is to receive consideration. Notwithstanding the extended use of electricity, these causes of accidents do not occur, and, in the opinion of many well qualified to give it, the danger arising from electricity is less than that arising from safety lamps, and enormously less than that arising from almost any explosive agent now in daily use.

Having dealt with this question, it remains to be asked, Is the present position of power distribution by electricity such that we may use it with confidence for the whole of the power required at a colliery? The author's answer to this is, Yes. In support of this may be given the following facts: The largest engine at a colliery is the winding-engine; and suppose this to require to be capable of developing power at full speed of 1,000 h.p., which is an outside figure, this could be well replaced by two motors of 500 h.p., one at each end of the shaft of the drum, without gearing. There are numerous cases of dynamos and motors of this power working with ease and satisfaction, and giving no difficulty whatever, and operated by ordinary mechanics with no more trouble than an ordinary steam-engine. Motors of smaller sizes are in use all over the world, with universal satisfaction as to ease of manipulation and low cost of maintenance.

Are the claims made for efficiency of electric distribution of power realised? On this point the author has examined carefully tests made by himself and by others on electric power plants, and has arrived at this conclusion—whilst the efficiency of distributing electric power and its utilisation in the motors does come up to that claimed, the efficiency of the production of electricity is not as a rule as high as is claimed or as high as may be realised, and the reason is this: sufficient account is not taken of the fact that the average load is considerably less than the maximum requirement, and the curve given—which is taken from an actual test of a direct-coupled engine and dynamo—will show how this operates. Whilst the efficiency of electric generation—that is, the proportion between the electric power delivered to the cables and the indicated horse-power of the engine—is as high as 86 per cent. at full load, it falls to 74 per cent. at half-load and to about 58 per cent. at one-quarter load. The reason for this is to be found in the power the engine takes to drive itself. The engine is generally arranged to work with an economical cut-off at the full load or maximum power, and consequently is larger than necessary for all smaller loads. It should be arranged to work with an economical cut-off at the average power, then at a larger power; although the consumption of steam per indicated horse-power would be somewhat greater, the mechanical efficiency would be so much better at the average load that considerable economy and, indeed, the best possible result would be obtained. The moral is to use engines with automatic expansion valves, permitting the engine to work with a cut-off as $\frac{1}{2}$ or $\frac{5}{8}$ of the total cylinder volume when developing the maximum power, and working with a more economical grade of expansion at the average load.

To apply the principles advocated in this paper, the method to be adopted should be as follows: When a colliery is opened an estimate must be made of the power which will ultimately be required for the whole colliery. It need not be all provided for at once, but the arrangements must be such that what is provided will be worked at an economical load, and that by simple duplication it may be increased. An example is given below which may be considered to represent an average case where there is no very heavy pumping.

TABLE OF POWER REQUIRED AT A COLLIERY.

	Maximum power. H.P.	Average power. H.P.	Minimum power. H.P.
Winding	700	225	0
Fan engine	60	60	60
Pumps	50	50	50
Haulage	200	100	0
Lighting	20	10	10
Screens	20	20	20
Shops at surface	20	5	5
Capstans for wagon handling	20	10	10
Total	1,090	480	155

The power required by the winding and haulage engines are what would probably be required in a colliery drawing about 1,500 tons per day, and the maximum power required by the winding-engine is reckoned on the assumption that the weight of the ropes is unbalanced, and the average on the assumption that the winding takes 40 seconds and the unloading and loading 25 seconds. Variations will correspondingly affect these points, and must be made to suit each case. These powers set down are those required at the separate machines, and if we take it that the loss in the cables at full load is 5 per cent., which will be ample, as the bulk of the power is not far from the source, and that at the average load and upwards the indicated power is as shown on the curve (steam dynamo efficiency)—that is, 100/86 of the power delivered to the cables, we get the following as the indicated power required at each load, which, assuming that the electric motor will transform only as much electric power into mechanical power as a steam-engine would convert of indicated power into mechanical power, gives a direct comparison between the actual indicated power required if all the engines were worked direct from the boiler, or by the distribution thus to be effected.

INDICATED HORSE-POWER OF GENERATING ENGINES.

Maximum.	Average.	Minimum.
$\frac{100}{86} \times \frac{100}{95} \times 1{,}090$	$\frac{100}{86} \times \frac{100}{97{\cdot}5} \times 480$	$\frac{100}{64} \times \frac{100}{95} \times 155$
1,330	572	265

Now it will be observed that the average power is 572 i.h.p. as compared with 480 i.h.p. actually required at the engines. But taking for the former Mr. Foster Brown's figure of 6lb., and for the latter 1½lb., the economy resulting is found from the fraction:

$$\frac{6}{1{\cdot}5 \times \frac{5}{4}\frac{1}{6}\frac{2}{0}} \text{ or } \frac{6}{1{\cdot}78} \text{ or } \frac{100}{29{\cdot}6},$$

not far differing from the possible economy spoken of early in the paper.

That such figures are realisable in practice is shown by the figures given in a paper read before the North of England Institute of Mining Engineers by Mr. Alexander Siemens, and published in Vol. 8, Part 2, of the *Transactions* of the Federated Institute of Mining Engineers. Tests are there recorded where, with a plant considerably smaller than that here considered, a consumption of 2·62lb. per electrical horse-power hour, equivalent to 2·25lb. per indicated horse-power hour, were obtained; and in the discussion on the same paper reference was made by Mr. D. B. Morrison to a plant using 2lb. coal per electrical horse-power hour, equivalent to 1·72 per indicated horse-power.

The writer is aware that in thus advocating the generation of the whole of the power in one engine or pair of engines he is advising a very radical departure from existing and well-tried

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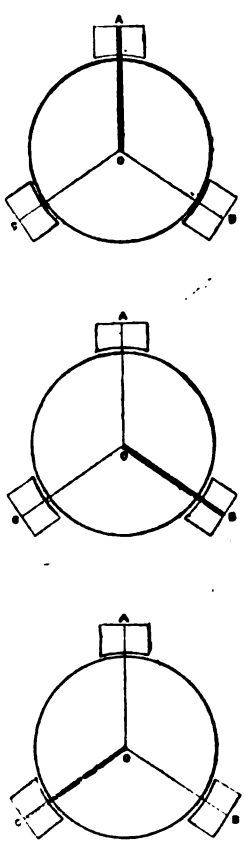
methods ; but the advantage in economy is so great that in his view a revision of method must take place, and in any case the subject is well worthy of consideration and discussion.

Notes on the Fundamental Principles of Multiphase Electric Motors.

The principles on which the action of these motors depend may be explained in general terms as follows—the explanation referring in particular to a three-phase system. Suppose in Figs. 1, 2, 3, there are three electromagnets radially fixed in positions O A, O B, O C. Suppose, by means which need not be gone into, they are magnetised in rotation—that is, first, as in Fig. 1, O A. There will then be a magnetic axis, O A. As O A is demagnetised, let O B be magnetised, the magnetic axis has reached O B. Repeat this with O C, and finally again with O A. The magnetic axis has been in each of the positions O A, O B, O C, and now is at O A. This result is the same as if O A only existed and had been mechanically rotated round the point O one revolution.



Figs. 1, 2, and 3.

cylinder. For instance, a turning moment of 1,820lb.-feet is given at about 88 per cent. of the full speed with no resistance in circuit. The same turning moment is given at 68 per cent. with some resistance added, and at 10 to 15 per cent. with a maximum of resistance. Taking the working load of this motor to correspond to 1,300lb.-feet turning moment, the efficiency curve of such a motor is shown at the right-hand side of the same plate. This curve is only an approximation, but will not differ much from the actual curve. The curve of current used is taken from tests of a three-phase motor made by the Allgemeine Elektricitäts-Gesellschaft (Berlin), and shows that when the power falls from 100 to 0 the current falls from 100 to 40, the speed being the normal speed of the motor. Fig. 4 shows comparative curves for a continuous-current motor, with field-magnet regulation, the supply being at constant pressure. It is assumed that the magnet strength may be doubled, taking that required to give the full output of the armature at normal speed as unity. The curve of turning moment of such a motor (Fig. 5) may be made a straight line at any speed between 100

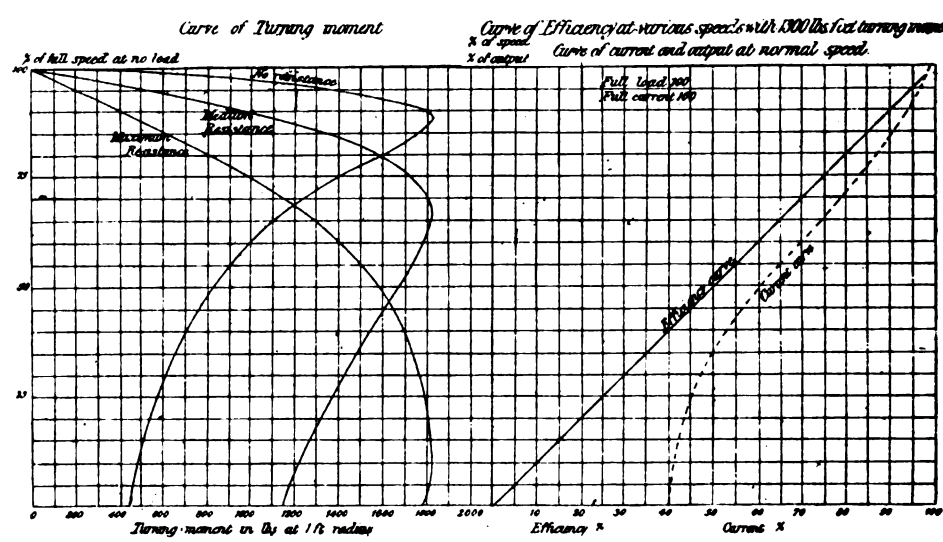

Curve of Turning moment
Curve of Efficiency at various speeds with 1300 lbs feet turning moment
% of full speed at no load
% of speed
% of output
Curve of current and output at normal speed
No resistance
Medium Resistance
Maximum Resistance
Full load 100
Full current 100
Efficiency curve
Output curve
Turning moment in lbs at 1 ft radius
Efficiency %
Current %

Fig. 4.

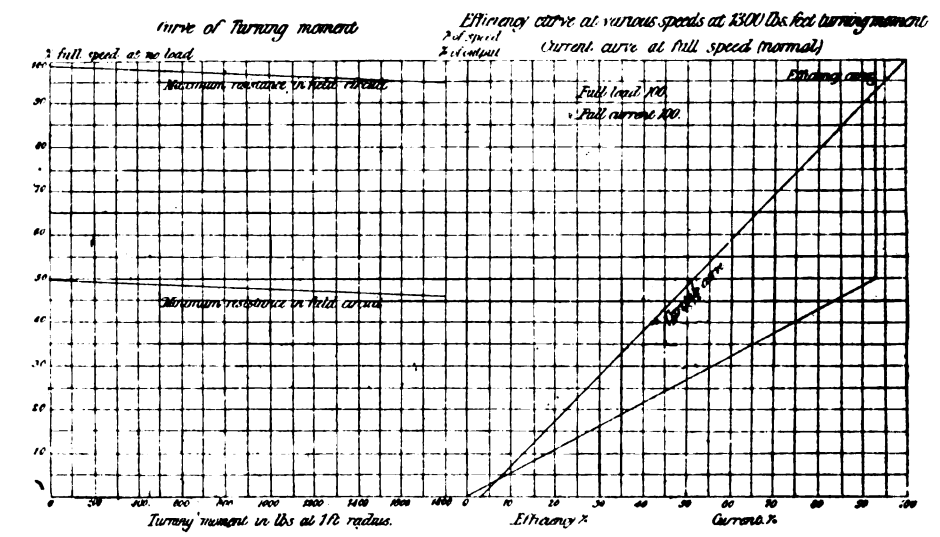

Curve of Turning moment
Efficiency curve at various speeds at 1300 lbs feet turning moment
% full speed at no load
% of speed
% of output
Current curve at full speed (normal)
Maximum resistance in field circuit
Full load 100
Full current 100
Efficiency curve
Output curve
Maximum resistance in field circuit
Turning moment in lbs at 1 ft radius
Efficiency %
Current %

Fig. 5.

It was shown by Arago as long ago as 1826 that if a magnet is rotated round a conducting body, such as a copper plate or cylinder, electric currents are produced in the conducting body, which currents attract the rotating magnet, and thus the conducting body is dragged by the rotating magnet. If, therefore, there is a cylinder of copper or of iron covered with copper conductors surrounded by such magnets, through which the current is in turn passed, producing a rotating magnetic axis, the cylinder will rotate. In practical working the currents are made to rise and fall in each magnet by using alternate currents—that is, currents rising and falling in the circuit—and arranging them so that the maxima in each of the circuits follow one another in the order described, and hence the name multiphase, for the phase of the current in each circuit differs.

Curves showing the turning moment (torque) exerted by a three-phase motor, copied from an article on "Electric Traction" by Philip Dawson, are given. The ordinates show the speed of the motor expressed as percentages of the full speed taken as 100. The abscissæ show the turning moment in pounds at 1ft. radius. The three curves show the effect of adding resistance to the circuits of the conductors on the rotating

per cent. and 50 per cent. of the normal speed, and, by inserting resistance in the armature circuit at any speed below this, it may be regulated to have any value at any speed, only defined by the ultimate current the armature will carry without burning up or mechanical breakdown. The efficiency at full turning moment by regulating the field will remain about 92 per cent. at all speeds down to 50 per cent. of the normal speed, after which it will fall with the speed. The current will at full speed be proportional almost exactly to the work done. The curves given are typical, to allow of comparison with the three-phase motor, and do not refer to a particular motor.

Almanacs, Diaries, etc.—The Brush Electrical Engineering Company, Limited, forward us a neatly-bound "Walker's No. 1 Diary" for 1896 ; John Heywood sends us "Calvert's Mechanics Almanack," which has now reached its twenty-third year of publication ; while from the offices of the *Indian and Eastern Engineer* we have received the useful quarto "Diary" for 1896 affiliated to that journal—a new feature of which is the table of conversion of English and metric weights and measures.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Orduna.—The municipal authorities invite tenders for the execution of a waterworks and electric lighting scheme. The estimate is 84,729 pesetas. Particulars of El Ayuntamiento de Orduna, Spain.

Betanzos.—Tenders are invited by December 28 for the concession of the electric lighting for 25 years of the town of Betanzos, Spain. Conditions of La Direccion General de las Administraciones Locales, Madrid.

Ploesti.—The Municipality of Ploesti invites tenders by January 15 for the lighting by electricity of the 46 principal streets in the centre of the town. Conditions from La Mairie de Ploesti, Roumania.

Brussels.—The Ministère de la Guerre invites tenders by January 15 for (1) a heating installation, (2) electric lighting in the new military school to be constructed in the Avenue de la Renaissance, Brussels.

Langeac.—The municipal authorities invite tenders for lighting the town by electricity during a period of 40 years. Water power is available. Specifications of M. Grenier, conducteur des Ponts-et-Chaussées à Langeac (Haute-Loire), France.

Aussig.—The communal authorities propose to have built a seven-mile single-line tramway. The choice of system is left open. Contractors are invited to place themselves in communication with the Stadtrath, Aussig-a.-d.-Elbe, Prussia. Tenders are to be in by January 31.

Pernambuco.—Tenders for lighting the city of Pernambuco by electricity are invited by the Government of the State of Pernambuco (Brazil). Particulars may be had on application to the Brazilian Consulate-General, Liverpool, or to the Brazilian Consulates in London, Manchester, and Glasgow.

Dublin.—Messrs. Arnott and Co., Limited, Dublin, invite tenders from competent firms for electric light and power installation to their new premises, Henry-street and Princes-street, Dublin. A copy of specification can be obtained from Mr. George P. Beater, M.R.I.A.I., architect, 17, Lower Sackville street, Dublin, on payment of £5. 5s., which will be returned on receipt of bona fide tender, which must be delivered at architect's office on or before January 8, 1896, endorsed "Electric Installation, Arnott and Co., Limited.

Chelsea.—The Guardians of St. Luke, Chelsea, invite tenders for fitting up an electrical wiring installation, with fittings, in the Chelsea Infirmary extension, Cale-street, Chelsea. Particulars upon application to the Guardians' architects, Messrs. Lansdell and Harrison, 12, Compton-terrace, Highbury, N., on depositing with them £5, which will be returned to those sending bona fide tenders not later than 12 o'clock noon on December 31, 1895. addressed to Mr. Wm. Miller, clerk to the Guardians, Guardians' Offices, 250, King's-road, Chelsea, S W.

Durban (Natal).—The Corporation desire tenders for the supply, for delivery at Durban. and fixing at Durban, of steam and electrical plant for the lighting of the borough by electricity. The work will be executed under the direction of Mr. Fletcher (borough engineer) and Mr. Hadfield (electrical engineer) at Durban. The plant required includes high-speed engines, dynamos, cables, arc and other lamps, accumulators, etc. Specifications and plans can be obtained from Mr. W. H. Radford, C.E., Angel-row, Nottingham, consulting engineer to the Corporation, on deposit of £5. 5s., which will be returned on receipt of a bona fide tender. Sealed and endorsed tenders, in duplicate, must be delivered at the offices of Messrs. Webster, Steel, and Co., agents to the Durban Corporation, 5, East India-avenue, Leadenhall-street, London, E.C , by 28th inst.

RESULTS OF TENDERS.

Newport.—The Free Library Committee have accepted the tender for an electric installation in the free library submitted by Messrs. Alger, of Newport, at £147, less £10 for old material.

Kingston-on-Thames.—The Corporation have accepted the tender of Mr. Mark Bell, at £19. 10s., for fixing guards round the machinery at the electric lighting works, as required by the Board of Trade inspector.

Leyton (Essex).—The Urban District Council have received the following tenders in connection with the projected electric lighting installation:

Buildings, machinery, foundations, water-tank, piping, drains, etc.

J. Holland	£2,976 0 0
H. J. Carter	2 586 18 3
H R. Rous (accepted)	2,394 14 7

Dynamos, switchboards, balancing transformers, wiring buildings, etc.

Holmes and Co.	1,726 10 0
Johnson and Phillips	1 602 6 0
Thames Ironworks Company	1,502 7 6
Brush Electrical Engineering Company	1,492 0 6
India Rubber, etc., Telegraph Works Company	1,479 8 2
Siemens Bros. and Co.	1,478 7 0
Laurence, Scott, and Co , Limited	1,411 5 0
Wigston Electrical Engineering Company	1,371 6 0
Crompton and Co., Limited	1,339 12 0
Electric Construction Company (accepted)	1,330 7 2
Nalder and Harrison Construction Syndicate	1,163 0 6

Gas producing plant.

Dowson Economic Gas and Power Company, Limited (accepted)	854 15 0

Gas-engines, piping, etc.

Crossley Bros.	1,342 14 0
Bilbie, Hobson, and Co.	1,523 0 0
Wells Bros.	1,144 6 0
C. L. Ritchie (part contract)	174 0 0

Storage batteries and cable connections.

Hedland Electric Storage Battery Company	1,113 0 0
Johnson and Phillips	1,082 10 0
Epstein Electric Accumulator Company	844 16 1
Conze and Simon	818 16 0
Electrical Storage Company, Limited	754 5 10
Pescatore (accepted)	748 4 6
Pritchett and Gould	632 16 6

Mains, including all trench work, cables, and conduits.

India Rubber, etc., Telegraph Works Company	11.354 15 10
Henley's Telegraph Works Company, Limited	10,286 11 10
Wigston Electrical Engineering Company, Limited	9,920 13 4
Glover and Co.	9 646 5 1
British Insulated Wire Company, Limited	9,380 15 5
Fowler-Waring Cables Company, Limited	9,295 16 2
Callender's Bitumen Telegraph and Waterproof Company	9,240 14 1
Siemens Bros. and Co (accepted)	8 996 1 6

BUSINESS NOTES.

Burnham (Essex).—The Lighting Act has been adopted for the whole parish.

Kingstown.—The Town Commissioners have sealed the application to the Board of Trade for a provisional order for electric lighting.

Folkestone.—The Town Council have approved the draft of the provisional order for electric lighting. The maximum expenditure is fixed at £50,000.

Leeds.—The Varley Mills at Stanningley, which are now leased by the Leigh Mills Company, of Coventry and Bradford, have been lighted throughout with electricity

Anglo-Portuguese Telephone Company, Limited.—Coupons No. 16 of the first mortgage and No 11 of the second mortgage debentures will be paid, less income tax, by Parr's Alliance Bank on and after January 1.

Lynn.—The Town Council have sealed the memorial to the Board of Trade asking for an electric lighting provisional order, and the proposed compulsory area for lighting has been enlarged to include Norfolk street.

National Telephone Company, Limited.—The transfer books of the 3½ per cent. debenture stock are closed from Monday to 31st inst. inclusive, for the preparation of the warrants for the half-year's interest due to January 1.

Coventry.—The Town Council have decided to instal the electric light in the free public library and to provide the cost out of the borough fund, it being reported that irreparable damage had already been done to valuable books by gas.

West Coast of America Telegraph Company.—The coupons due the 31st inst. on the debentures of this Company will be paid by Messrs. Barclay and Co., Lombard-street, London, E.C., and should be left three clear days for examination.

Newmarket.—The Urban District Council have received a letter from the Newmarket Electric Lighting Company asking the consent of the Council to their provisional order. It was decided to let the matter stand over until the next meeting.

Hobart Electric Tramway Company Limited.—Mr. G. Carnaby Harrower, College-hill-chambers, E C., has resigned his position as manager in London of this Company, and the offices have been removed to Mansion House-chambers, E.C.

Brighton.—The Watch Committee have resolved that the electric light be installed in the Level Police Station and the police offices at the Town Hall, and Mr. Wright was instructed to obtain tenders from local electrical engineers for carrying out the work.

Barnsley.—The Houghton Main Colliery Company, Barnsley, Yorks., have just had put down by Messrs Crompton and Co., of Mansion House-buildings, London, an electrical plant for lighting the whole of the surface, including the head offices weigh-houses, workshops, engine houses, screens, and the pit yard.

Bridgwater.—In the course of a discussion on the lighting of the cattle market, it was stated that the Corporation had adopted a suggestion made by the Lighting Committee to appoint a small committee to consider the whole question of the lighting of the town as regards electricity or the taking over the gasworks.

City and South London Railway.—The returns for the week ended December 22 were £1 013, compared with £968 for the corresponding period of 1894, being an increase of £45. The total receipts for the half-year 1895 were £22,553, compared with £22,447 for the corresponding period of 1894, being an increase of £106.

Dewsbury.—The directors of the Heckmondwike Collieries, Limited, have placed an order with Messrs A. Hirst and Son, electrical engineers, Crescent Works, Dewsbury, for an electric

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pumping plant for their Park Farm Colliery. The order comprises engine, dynamo, two motors, and two sets of triple-ram pumps, and about 1¼ miles of cable.

Dunfermline. — The Dunfermline Town Council recently adopted the Gas Supply (Scotland) Act, with a view to negotiating with the Dunfermline Gaslight Company for the purchase of the Dunfermline gasworks, but a remonstrance against the adoption of the Act has been lodged with the town clerk by a section of ratepayers, and this will necessitate a *plébiscite*.

Electric and General Exploring Syndicate, Limited —This Company has been registered with a capital of £5,000 in £1 shares. Object: to acquire any lands, buildings, hereditaments, stocks, shares, etc., to develop and turn to account the same in such manner as the Company shall see fit, and to carry on all kinds of agency business. No names of directors are given.

Dover.—The Electricity Supply Company announce that from the commencement of the New Year their charges will be reduced to an average of 6d. per Board of Trade unit, which means that an 8-c.p. light will cost for one hour per day throughout the month 6d. only. It is stated that the company have obtained an order to light the Lord Warden Hotel and other large buildings.

Disley (Cheshire).—The Rural District Council have discussed the adoption of the Lighting and Watching Act without the sanction of the parish meeting. Nothing beyond getting the information about the cost of the lamps required, etc , could be done, and this it was decided to obtain from a number of local authorities. The chairman expressed himself strongly in favour of electricity being used.

New Electric Light Syndicate, Limited.—This Company has been registered with a capital of £2,000 in £1 shares. Object: to enter into an agreement, made December 3, with B. F. de Margenstein, and to carry on, in the United Kingdon or elsewhere, the business of dealers in electric batteries, lamps, switches, etc. The directors are A. C. Miles and the Hon. C. Bingham. Registered office: 268, Strand.

Salt Lake and Ogden Gas and Electric Light Company, Limited.—The Gas, Water, and General Investment Trust, Limited, give notice that the coupons of the 6 per cent. first mortgage gold bonds of the Salt Lake and Ogden Gas and Electric Light Company due on January 1 next will be paid at the National Provincial Bank of England, Limited, 112, Bishopsgate-street, E.C., or at the Farmers' Loan and Trust Company of New York.

Portsmouth.—There is talk of lighting the Portsmouth hospital with electricity. The value of the light in the operating-room would be considerable, and its use in the sick wards would tend to keep the atmosphere purer. Specifications for carrying out an experimental installation in the accident and casualty wards and in the new building in course of erection for the accommodation of the nurses will be submitted and fully discussed at the next meeting of the committee.

Bradford.—From the abstract of the Corporation accounts issued by the borough accountant, Mr. G. A. Thorpe, it appears that the electricity works revenue account for the past year shows a gross income of £11 737, and expenditure £5,773, leaving a trade profit of £5,964. Against this, interest and sinking fund, £4,095, leave £1,869 to be carried to net revenue account This is further charged for depreciation of plant and machinery £1,063, and the net profit is shown at £146 for the year.

Mile End (London).—The Guardians are contemplating lighting their institutions by electricity, and a committee has been making enquiries of other Guardians as to its advantages or otherwise in point of cost and convenience over gas. The Guardians have decided to appoint a consulting electrician, and a committee appointed for the purpose brought up at the last meeting five candidates which they had selected for the post. These having been interviewed by the Board, Mr. Jenkinson was elected.

Grimsby.—The Public Lighting Committee having met to elect a new chairman, Mr. Shephard asked what had been done by the Electric Lighting Sub-Committee. Mr. Curry replied that they had not yet concluded their enquiries, but they would be able to save £50 per year from the lamps they intended doing away with. The outlay for providing light for the lamps suggested, accumulators, etc., he thought would be about £400, and other members referred to the present dynamo not being expected to stand for a much longer time.

Electric Cranes.—Mr. Thomas Smith, of the Old Foundry, Rodley, has constructed an electric overhead traveller capable of lifting, lowering, and travelling with loads of 10 tons on a span of 42ft. The hoisting motion is double-purchase spur gearing, controlled by double friction cones. The drum having spiral grooves, the pulley in the block is grooved to suit the chain. The block has an iron swivel hook. A powerful friction brake is provided and controlled by a screw lever with a handwheel. The crane is driven by an electric motor.

Calne (Wilts.).—On a discussion occurring in the Town Council on the lighting of the public hall, Mr. Bownas said that the electric light question should be taken up, seeing that they had a stream of water close to the hall. Mr. Maundrell remarked that an experienced electrician would be in the town in a few days, and perhaps the Council would like his opinion as to the feasibility of taking up the electric light question. This the Council decided would be the best thing to do, and they voted the sum of £1. 1s. as a fee for the information.

Bournemouth.—The Town Council have referred back to committee an application from Messrs. Tyrell and Sons to put up electric light columns in the front of their premises. The Lighting Committee recommended six columns, the design to be approved, the lights to be kept in all the time the public lights are lit, and with the right of the Council to withdraw at any time. At a meeting of the Lighting Committee the surveyor reported verbally that there had been an accident at a transformer-box in Poole-road, and it was recommended that the surveyor be instructed to ascertain further particulars and communicate with the Board of Trade.

New Appointments —Messrs. P. R. Jackson and Co , Limited, of the Salford Rolling Mills, Manchester, have just made the following additions to their staff: Mr. W. H. Ravenshaw, A.M.I.C.E. (of Booth and Ravenshaw, 110 Cannon-street, London, E C.), as consulting electrical engineer; Mr. E. J. Blandy, A.M.I.C E, as representative in South Wales and the Midland Counties; Mr. A. M. Shepherd, of 32, Albany-road, Ealing, W., as representative in London and Southern Counties; Mr. W. F. Jones (late of Easton, Anderson, and Goolden) as assistant engineer; and Mr. Felix J. Howitt (late of the Norwich Electricity Supply Company), as assistant electrical engineer.

Worthing —Considerable alarm was created in Worthing on Monday night, when, at about eight o'clock, the whole of the gas-lights were suddenly extinguished and the streets remained in darkness through the night. Shopkeepers hastily put up their shutters, hundreds of persons hurried as fast as the condition of the thoroughfares would permit to the gasworks, the news spreading in all directions that they were on fire. A great flare of light immediately over the works intensified the public alarm. The hasty despatch of the fire-engine confirmed the truth of the rumour. Fortunately, however, the fire, which had been caused by an explosion in the governor-house, was soon subdued and the gas was turned off.

Cardiff.—The Lighting Committee of the Town Council have passed the following resolution expressing their appreciation of the services of Mr. W. H. Massey, consulting electrical engineer: "This committee desire to place on record their appreciation of the valuable and important services rendered to the town of Cardiff by Mr. W. H. Massey, M.I C.E., as consulting engineer in connection with the laying down of the system of electric lighting within the borough under the Cardiff Electric Lighting Order, 1891, and also to convey to Mr. Massey their sincere thanks for the conspicuous ability displayed by him in the carrying out of this great work, and of the many intricate and important details in connection therewith."

Swadlincote (Derbyshire) —It was announced at the Urban Council meeting, with regard to electric lighting at Stanton, that Mr. Johnson, on behalf of Lord Carnarvon, had consented to light from 16 to 50 lamps of 32 c.p. each at £1. 5s. per lamp, the lamps to be kept lighted from half-an hour after sunset to 11 p.m from September 1 in each year to April 30 following, the arrangement to continue for 10 years if the Council require it so long. The committee therefore recommended that Stanton be lighted by electricity, and that Lord Carnarvon's offer be accepted, the lamps to be fixed from the colliery to the Board schools and past Mr. Wright's house, and that tenders be invited for carrying out the works. The report was adopted.

Newcastle-on-Tyne.—The Newcastle City Council have again had the tramways question before them, when a resolution was moved to the effect that a petition be presented to Parliament for leave to bring in a Bill for the extension of the system, with power to work the new sections by cables, electricity, or other motive power. Some of the members complained that the petition said nothing as to the working of the trams by the municipality. The Town Clerk said the Council had already decided against that course, The only municipality that had obtained that power was Glasgow, and Newcastle could not ask for the power in the present position, although it might do so afterwards. The resolution was carried.

Glasgow.—The Town Council have discussed a recommendation by the Committee on Electric Lighting to appoint a sub-committee to co-operate and take such action as they might deem expedient, in conjunction with the special sub-committee of the Watching and Lighting Committee, to consider the question of electric lighting, and particularly what kind of lamp should be used. Mr. W. F. Anderson said he had marked that part of the minutes, not knowing but that it might mean a deputation of six members of Council, and probably three officials, to go anywhere or everywhere gathering information about electric lighting. This deputation business was becoming a scandal. After further discussion the matter was sent back to the committee.

Tottenham (Middlesex).—The General Purposes Committee have reported to the Urban District Council that they had a preliminary interview with Mr. Hastings Medhurst, M I.E E, of Victoria-street, S.W., with whom they had generally discussed the question of electric lighting in connection with the provision of a dust destructor. The committee unanimously recommended the Council to employ Mr. Medhurst to prepare reports upon the question of electric lighting and the provision of a refuse destructor for the district separately and combined at an inclusive fee of 50 guineas, this fee merging into his commission providing the Council decided to employ him to superintend the works. After a long discussion the report was agreed to.

Chiswick (Middlesex).—The District Council have received a letter from the Bourne-Grant Electric Lighting Company, stating that they had expected to commence the erection of the electric light station at the beginning of the year. They were prepared to commence the shaft forthwith and understood that the difficulty as to the destructor had been obviated. The clerk stated, in reference to this matter, that he had called at the office of Messrs. Currey and Co., the agents to the Duke of Devonshire, and they

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were not at present able to return the agreement as to the erection of the electric lighting works and dust destructor. The letter was referred to the Works Committee, and it was decided to write to the Duke of Devonshire calling his attention to the delay complained of.

Tunbridge Wells.—A local paper says: "Several additions are daily being made to the list of customers for the electric light, and it is now to be installed in the Kentish Hotel. This will be a great benefit to the town, as we have had several instances of visitors who have gone to Eastbourne and other resorts because being used to the convenience of the electric light they could not do without it and therefore would not stop at Tunbridge Wells. We hope that other hotels will follow the example of the Kentish, as this will have an important effect in attracting visitors to the town. During the present week Shandon, the residence of the Mayor, and Dunorlan, the residence of B. H. Collins, Esq., have had the light installed. Mr. Gallard is also installing the light in all new houses that he is building."

Telescopic Ladders.—Messrs. J. H Heathman and Co., of Endell-street, London, W.C., seem to keep *au fait* with electric lighting requirements. They are always endeavouring to improve the details of their patent telescopic ladders, trestles, steps, tower ladders and scaffolds, so that they may be economically employed for installing and maintaining electric lamps Five of their tower ladders are, we are informed, used in the streets of Edinburgh, while at Tunbridge Wells Mr. Boot says Heathman's improved Brighton-pattern carriage ladder admirably suits their hilly roads, and Messrs. Frank Suter and Co. wrote this firm that a telescopic tower ladder purchased for the contract of installing electric lighting in the Nottingham art galleries saved more than its cost on the contract.

Liverpool.—The Lighting Committee of the City Council have discussed the estimates for the ensuing year, and it is believed that the new Council will entirely approve of the decisions arrived at, although they will involve extra expense. The committee determined to provide sufficient light, not only in the courts and alleys of Liverpool, but in the main arteries of the city, thus affording the necessary protection to the public throughout the night. Moreover, arrangements have been made in the estimates for the better lighting of the extended areas, though it should, in justice to the Toxteth authority, be said that the lighting in that township needs no improvement, the requirements being more than fulfilled. A considerable addition to the number of hours will be made in each of the other district.

Electric Lighting in West Australia.—The eighth annual dinner of the workmen of Messrs. J. H Holmes and Co., electrical engineers, Newcastle, has been held. Replying to the toast of the firm, Mr. Ellwood Holmes regretted that his brother had been unable to join them that night, having been called away to Manchester, but they would be interested in knowing that he had gone to see a gentleman from the Perth Gas Company of Western Australia, with whom the firm had just completed a contract of about £5,000 for the supply of dynamos, engines, and boilers This showed what a very go-ahead class of men they had in the Colonies, when such a company as the Perth Gas Company had begun to undertake electric lighting as well as the supply of gas. They sold gas he believed, at 12s. 6d or 15s per 1,000ft, about 10 times the price it was in Newcastle, and now had undertaken the supply of electricity. It was a very good sign to see the Colonies taking up electricity in the manner they were doing.

British Electrozone Corporation, Limited —This Company has been registered with a capital of £250,000 in shares of £5 each. Object: to adopt and carry into effect an agreement, made December 9, between John A. Barham and W. Digby of the one part and F. W. Manley, on behalf of this Company, of the other part; to acquire any letters patent, patent rights, concessions, protective trade marks, designs, and copyrights in connection with Woolf's electrolysing, bleaching, and disinfecting process in the United Kingdom, and in any colony and dependency of the United Kingdom, and in any foreign country other than the United States of America and the Hawaiian Islands, and generally to carry on business as manufacturers, merchants contractors, and engineers, etc. The signatories to the memorandum of association are: A. C. C. Todd, Trafalgar-buildings, Charing Cross; J. D. Jehu, Holly Lodge, Keston, Kent; G. Hazelgrove, Chesterton, Clifton-road, Wellington, Surrey; A. J. Lusty, Goldhurst-mansions, Goldhurst-terrace, Finchley-road, N.W.; A. Riding, Wesleyan Training College, Westminster; A E. Griesbach, 17, Gloster-road, Kew; E. H. Selby, 8, Buckingham-street, W.C.

Preston.—At the monthly meeting of the Preston Town Council Councillor M. B. Copland moved the adoption of a recommendation from the Markets and Town Hall Committee, "that the Town Hall and Public Hall be lighted by electricity, at the estimated cost of £2,024." Councillor Healey supported the motion, and Alderman Edelston said that, although he would have liked to see the electric light, he must, under the circumstances, oppose the motion Preston was not a poor town; it was, apart from the Ribble scheme, a rich town. But they had the Ribble scheme, and they had to make the best of it, and provide for it at any cost. An amendment that the matter be referred back was carried by 21 votes to 9. In connection with the electric lighting scheme, the National Electric Supply Company, Limited, have written to a local paper: "Dr. Hopkinson, who has been retained by the Corporation to advise them on the subject, has given them his unbiassed opinion as to the cost of current, which verifies and substantiates what we claim to be the correct comparison between the cost of electric light and gas in Preston. He advises 'that, given a supply of electricity at the normal cost per unit (6d.), and no more light provided than at present, the cost of the supply of electricity will be the same as the present supply of gas.' We would, however, point out that at 4½d. per unit (the price offered to the Corporation) they would find the cost to be 25 per cent. less than they now pay for gas for an equivalent amount of light."

Swansea.—The Streets Committee have considered an application from the National Telephone Company, Limited, for permission to lay three 3in. iron pipes, with manholes, etc, for carrying telephone wires under the pavements from the Central Exchange, Wind-street, to a pole in the grounds of the Royal Institution, and the borough surveyor was instructed to communicate with Mr. Manville, the electrical engineer, as to whether the proposal would in any way affect the intended system of electric lighting and traction. In accordance with notice of motion, Alderman Leeder has moved in the Town Council "That nothing further be done with the scheme of electric lighting until a public meeting has been held." Alderman Leeder said his object was if possible, to have a meeting at which the gentlemen who believed in the scheme would have an opportunity of thoroughly explaining it to the ratepayers, who could then form their opinions and make up their minds before they were asked to pass the statutory resolutions The Mayor remarked there was little or no expense likely to be incurred within the next couple of weeks, and in view of the Christmas season it was his intention to have a meeting called in the middle of January, when the ratepayers would have an opportunity of expressing their views on the matter. Although they had received tenders for the erection of the electric light station and dust destructor, they had not yet been opened, and it was not their intention to open them until the final vote had been taken on the purchase of the tramways, because one thing must stand or fall by the other. It was ultimately agreed that there should be a preliminary meeting of the ratepayers before the formal meeting to pass the statutory resolution.

Eccles (Lancs.).—The Town Council in committee have received a deputation from the Property Owners' Association to make a representation in opposition to the adoption of the electric system of lighting. Subsequently the town clerk laid before the Council the information he had obtained from those boroughs in the kingdom which had adopted the electric lighting system Of these there were 115, and 69 of these were in the hands of the municipal corporations. There were, in addition, 13 or 14 works projected or in course of construction, and Alderman Kendall moved the adoption of the deferred proceedings of the Town Hall and Electric Lighting Committee of November 26 last, and that the corporate seal should be attached to a contract in respect of electric lighting works, and that the committee be authorised to apply to the Local Government Board for powers to borrow money for the purpose. The Council had already spent over £1,000 in enquiries and preparations, and in order to prevent any private company coming in to take advantage of the provisional order which the Board of Trade had granted to the Corporation, he thought they would be unwise not to proceed. Alderman Spary moved as an amendment: "That no further proceedings be taken or expense incurred by the committee with regard to the introduction of electric lighting into the borough until the question has been referred to a poll of the ratepayers by ballot or voting papers," but this proposition was ruled out of order, and Mr. Nuttall moved a further amendment deferring the question, and it was eventually decided that the matter should be left to the Town Hall and Electric Lighting Committee, who had hitherto had the management of the whole affair, and the question will therefore come up for rediscussion on February 2.

South Staffordshire Tramways.—Speaking at the tenth annual supper to the employés of the company at Darlaston Town Hall, Mr. S R. Bludstone (vice chairman of the company) said it was well known that the license to work the steam trams would expire with the close of the year, and there was a widespread expectation that the service would be discontinued from that date, but that was not his opinion. The West Bromwich and Handsworth authorities desired the substitution of a cable system for the steam traction; but that was impracticable, because the cost would be too great, and there was not sufficient traffic to warrant the directors in incurring such a great expenditure. The whole of the authorities—those of West Bromwich in particular—he had no hesitation in saying would be consulting the interests of the inhabitants of their districts if they accepted the overhead electric system. As to the difficulties connected with the continuance of the contract for the running of that system between Walsall, Wednesbury, and Darlaston, he hoped and believed that they would be overcome, although the Electric Construction Company were trying to screw another penny per mile—viz., 9d instead of 8d.—out of the company. As a matter of fact, there were portions of that branch of the system which did not pay the tramway company even at 8d per mile They had spent during the last six months twice as much upon the permanent way as during the six previous months, and now the permanent way was in a perfectly satisfactory condition. In fact, the plea that the condition of the road bed and rails was causing damage to the cars was nonsense; and if the cars were not in a good condition, it was because the electrical company were now doing their own repairs, instead of having them done, as previously, in the South Staffordshire Company's shops.

Dublin.—A deputation from the Dublin Southern District Tramway Company have waited on the Pembroke Town Commissioners with reference to an extension of their tramway line. Dr. Carte, chairman of the tramway company, said it was proposed to extend their system through parts of the Pembroke township. The first line that they wished to construct was from the head

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of the Appian Way along Clyde road to Ball's Bridge. The second was along Eglinton road, joining the Clonskeagh and Donnybrook road and the Anglesea road to the show grounds at Ball's Bridge There would be a small junction between the Donnybrook and Stillorgan roads Then they were going to Ringsend and Irishtown to join the existing line. They proposed to run through Brunswick street to Ringsend The last bit asked for was from Baggot-street Church along Pembroke road to the corner opposite Lansdowne-road. They proposed to use electricity as the motive power on the new lines, and were going now for an Order in Council, which they as an existing company had to do. The electric cars would run so smoothly that no nuisance would be constituted by them in the way of noise. In America, tramcar accidents had diminished since the introduction of electricity. This arose chiefly from the fact that there was so much more control over an electric car. A horse car could not be stopped in less than a length and a half, while an electric car could be stopped in 6ft. or 7ft The Chairman said that they did not yet know the wishes of the majority of the Board on this subject; and Mr. Murphy suggested that the Board should give a general assent to the proposal to introduce electric lines, reserving power subsequently to insist on any reform of electric traction that they wished He thought it probable that the Corporation and the Rathmines Commissioners would assent to this course The deputation then withdrew, and the matter was referred to the Parliamentary Committee.

Audits.—The following correspondence has been sent to the *Times* for publication: "Sir,—The attention of the council of this institute was directed to an advertisement which appeared in the *Times* of November 29 last giving notice that at a general meeting of an electric light supply corporation a proposal would be made: 'That in order to save the trouble and expense of a double yearly audit it be and is hereby resolved that the auditor appointed by the Board of Trade for the official audit should also act as the shareholders' auditor.' I was instructed to write to the Board of Trade, and to ask whether in their opinion an official auditor of that Board is at liberty to accept the appointment of shareholders' auditor in an electric light company, and to point out that the functions of an official auditor and a shareholders' auditor are not only different, but to some extent conflicting. In reply, I have received a letter from the Board, a copy of which I enclose, and which I shall be glad if you will publish in your next issue—I am, sir, your obedient servant, W. G. HOWGRAVE secretary, Institute of Chartered Accountants in England and Wales" "Board of Trade (Railway Department), 7, Whitehall-gardens, London S W., 18th December. 1895. Electric Lighting Acts, 1882 to 1890. Sir,—With reference to your letter of the 5th inst, calling the attention of this Department to a resolution dealing with the question of the audit of the accounts of the . . . which it is proposed to submit to the next general meeting of the shareholders of the . . . . I am directed by the Board of Trade to state that they hold it to be outside the province of the auditor appointed by them under the terms of the provisional order granted to the company to act as auditor on behalf of the shareholders I am further to state that the audit conducted by this auditor is of a different character to that of a shareholders' audit, and has in view different objects, and it appears to the Board of Trade that it rests with the company to determine whether they are acting legally if they entirely dispense with the audit contemplated by the Companies Acts.—I am, Sir, your obedient servant, FRANCIS J. S. HOPWOOD. The secretary to the Institute of Chartered Accountants, Moorgate-place, E.C."

Bath.—On the motion of Alderman Sturges, it was agreed at the last meeting of the Urban Sanitary Authority that the seal of the Authority should be fixed to the memorial to the Board of Trade for the grant of the provisional order. Alderman Sturges referred to the issue of the report of Mr. Hammond on the electric lighting question. It was a "very exhaustive and masterly production, requiring a great deal of thought" The Lighting Committee had not yet met to consider it, but when they did so it would be their duty to send up a recommendation This would be the work of the near future The substance of Mr. R. Hammond's report to the Lighting Committee of the Urban Sanitary Authority on the value to the city of the property (or any portion thereof) of the City of Bath Electric Lighting and Engineering Company, Limited, is as follows. It deals with the subject under three heads: (1) The desirability of electricity works being laid down by the Corporation; (2) the system of generation and distribution best suited to the city, and (3) the advisability of the acquisition of the existing electric light works. Mr. Hammond thinks it must be conceded (*a*) it is the universal experience that even in places where gas is supplied at a very low rate there is a sufficient number of enlightened private consumers to make electricity supply a paying business; (*b*) electricity supply works dealing with both public and private lighting are becoming general; (*c*) where works have been laid down on sound lines they are proving a financial success; (*d*) the tendency is for local authorities to lay down their own works, and in all cases to obtain powers to deal with both public and private lighting; (*e*) there is great probability of decreased costs as the business extends; (*f*) electricity supply works for private lighting laid down by a corporation are likely to be more economically carried on than works laid down by a company, and therefore afford a cheaper supply to the ratepayers; (*g*) statutory powers for the establishment of works for private lighting may become of great value to the community, and should be vested in the Corporation. On the question of the system to be adopted, Mr. Hammond discusses various systems at length. Judging Bath to be a progressive city, he points out that it is imperative that the pioneer system should be one of great elasticity, and capable of almost indefinite extension. An inspection of the area of Bath shows that the demand for electrical energy will probably eventually come from widely-scattered points, which can only be economically coped with by high-tension feeders. The system which he considers best for the city is the one that is at present used by the local company. On the question of the advisability of the acquisition of the existing electric light works, Mr. Hammond considers it safe to prognosticate from the decisions of the Board of Trade, in similar cases, that they will refuse their consent to the application of the company and grant that of the Corporation. He goes on to point out the desirability of a friendly settlement on lines equitable to the conflicting interests It would have the warm approval of the Board of Trade. The generating plant of the company, Mr. Hammond states, is not of the latest type nor of the highest efficiency. Some of the remaining apparatus is, however, of excellent quality and quite suitable for the work which it has to do It is evident that if on the expiry of the company's license the plant were sold off it could only be realised at a disastrous sacrifice. Whereas, on the other hand, if the Corporation were laying down their own works, there are some portions of the company's plant which could not be procured at a lower figure than that at which they stand on the company's books. After adverting to the fact that the space for extension at the present works is limited he remarks that he does not consider that the idea of two separate works should be dismissed as impracticable, but obviously they could not be worked as economically as central works together. In the matter of distribution, however, advantage would accrue from feeding from two distant points, and if the present works could be obtained at a fair price, it might suit the Corporation very well to begin their operations there. Mr. Hammond then goes into a careful consideration of the company's buildings and plant, incidentally mentioning that everything bears the impress of careful and painstaking management The total of his valuation (excluding the land which he thinks should be valued by the surveyor) amounts to £29,285. Considering alternatives to purchase, he remarks that if the Corporation fail to come to terms with the company they can, of course, lay down their own works, whether at the Bathwick Mills, where the waste gases would prove a useful adjunct for working the day load, or at the destructor, where the water power would prove of service. On the question of profits, he states that the improvements which he suggests in the works would tend to very much cheaper working, and he thinks that with 10,000 lights already connected, and a revenue of over £5,000 a year, a profit sufficient to cover the interest and sinking fund might be relied upon from the very start

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	5⅞-6¼
Brush Company, Ordinary	3	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	1⅞-2⅛
—— 4½ per cent. Debenture Stock	100	112-115
Charing Cross and Strand	5	5¼-5⅝
Chatham and Rochester	—	—
Chelsea Electricity Company	5	6¾-7¼
—— 4½ per cent. Debentures	100	116-119
City of London, Ordinary	10	12¾-13¼
—— 6 per cent. Cumulative Pref.	10	15½-16
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	40-42
—— 4 per cent. Debenture Stock	100	130-132
—— 5 per cent. Pref. Shares	10	14⅞-15¼
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	6	8¼-9
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	2-2½
Edison and Swan United Ordinary	3	1¾-2¼
—— 4½ per cent. Debentures	100	104-107
Electric Construction, Limited	2	⅝-¾
—— 7 per cent. Cumulative Pref.	2	2-2½
Elmore's Copper Depositing	2	¼-½
Elmore's Wire Company	2	⅜-½
Fowler-Waring Cables	5	¼-¾
W. T. Henley's Telegraph Works, Ordinary	10	13¼-14½
—— 7 per cent. Preference	10	15½-16½
—— 4½ per cent. Debentures	100	108-111
House-to-House Company, Ordinary	5	4½-4¾
—— 7 per cent. Preference	5	8-8½
India Rubber and Gutta Percha Works	10	18-19
—— 4½ per cent. Debentures	100	101-103
Kensington and Knightsbridge Ordinary	5	7⅞-8¼
—— 6 per cent. Pref.	5	7-7⅝
Liverpool Electric Supply, Ordinary	5	7⅞-8⅛
Liverpool Overhead Railway	10	11⅜-12
—— 5 per cent. Pref.	10	15½-15¾
—— 4 per cent. Mortgage Debentures of £100	100	114-116
London Electric Supply	5	⅜-½
Metropolitan Electric Supply	10	10½-11½
—— 4½ per cent. First Mortgage Debenture Stock	100	117-120
National Telephone, Ordinary	5	5⅞-6⅛
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	15½-16½
—— 5 per cent. Non. Cum. Third Pref.	5	6¼-6½
—— 3½ per cent. Deb. Stock	100	106-108
Notting Hill Company	10	8½-9
Oriental, Limited, £1 shares	1	1-1½
—— £5 Shares	5	7⅞-8¼
—— £4½ shares	4½	6¼-6⅝
Oriental Telephone and Electric Company	1	9/16-11/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	105-106
Southampton Electric Company	—	—
St. James's and Pall Mall, Ordinary	5	8¼-8⅝
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	39-41
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	4	4⅜-5
Westminster Electric Supply, Ordinary	5	8¼-8⅝
Yorkshire House-to-House	5	6¾-7¼

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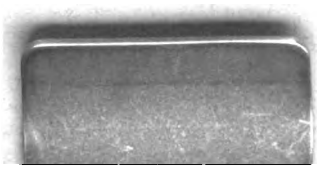

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